A NATURAL HISTORY

OF THE GLOBE, OF MAN, OF BEASTS, BIRDS, FISHES, REPTILES, INSECTS AND PLANTS.

FROM

THE WRITINGS OF BUFFON, CUVIER AND OTHER EMINENT NATURALISTS.

A NEW EDITION,

WITH MODERN IMPROVEMENTS, AND FIVE HUNDRED ENGRAVINGS.

BOSTON:

GRAY AND BOWEN.

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EDITED BY JOHN WRIGHT,

MEMBER OF THE ZOOLOGICAL SOCIETY OF LONDON.

A NEW EDITION,

WITH IMPROVEMENTS FROM GEOFFREY, GRIFFITH, RICHARDSON, LEWIS AND CLARK, LONG, WILSON, AND OTHERS.

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NATURAL HISTORY.

CHAP. XII.

Of Insects in general...Insects without Wings...The SPIDER... *House, Garden, Wandering, Field, and Martinico, Spiders ...The Water Spider...The Tarantula...The Great American Spider...The Barbary Spider...The* FLEA...*The* LOUSE... *The Leaf Louse...The* BUG...*The* WOOD LOUSE...*The* WATER FLEA...*The* SCORPION...*The* CENTIPES...*The Gally-worm...The* LEECH.

OF all animated beings, man offers the most wonderful variety in his internal conformation; quadrupeds come next; and other animals follow in proportion to their powers or excellencies. Insects seem, above all others, the most imperfectly formed; from their minuteness, the dissecting knife can go but a short way in the investigation; but one thing argues an evident imperfection; which is, that many of them can live a long time, though deprived of those organs which are necessary to life in the higher ranks of nature. Many of them are furnished with lungs and a heart like nobler animals; yet the caterpillar continues to live, though its heart and lungs, which is often the case, are entirely eaten away.

If insects be considered as bearing a relation to man, and as assisting him in the pleasures or necessities of life,

they will, even in this respect, sink in the comparison with the larger tribes of nature. It is true, the bee, the silkworm, the cochineal fly, and the cantharides, render him signal services; but how many others of this class are either noxious or totally unserviceable to him. Even in these countries, where all the noxious animals have been reduced by repeated assiduity, the insect tribes still maintain their ground, and are but too often unwelcome intruders upon the fruits of human industry. But, in more uncultivated regions, their annoyance and devastations are terrible. What an uncomfortable life must the natives lead in Lapland, and some parts of America, where, if a candle be lighted, the insects swarm in such abundance as instantly to extinguish it with their numbers; where the inhabitants are obliged to smear their bodies and faces with tar, or some other composition, to protect them from the puncture of their minute enemies; where, though millions are destroyed, famished millions are still seen to succeed, and to make the torture endless?

Yet, while we are thus fixing the rank of a certain class of animals, it seems necessary to define the nature of those animals which are thus degraded. Definitions, in general, produce little knowledge; but here, where the shades of nature are so intimately blended, some discrimination is necessary to prevent confusion. The smallness of the animal, for instance, does not constitute an insect; for then, many of the lizard kind, which are not above two inches long, would come under this denomination; and if the smaller lizards, why not the crocodile, which would be a terrible insect indeed? In the same manner, smallness, with a slow, creeping motion, does not constitute an insect; for, though snails might be called insects with some propriety, the whole tribe of sea shell fish would then have equal pretensions, and very troublesome innovation would

be brought into our language, which is already formed. Excluding such animals, therefore, from the insect tribe, we may define insects to be *little animals without red blood, bones, or cartilages, furnished with a trunk, or else a mouth, opening lengthwise, with eyes which they are incapable of covering, and with lungs which have their openings on the sides.* This definition comprehends the whole class of insects, whether with or without wings, whether in their caterpillar or butterfly state, whether produced in the ordinary method of generation between male and female, or from an animal that is itself both male and female, or from the same animal cut into several parts, and each part producing a perfect animal.

In a cursory inspection of the insect tribe, the first animals that offer themselves are those which want wings, that appear crawling about on every plant, and on every spot of earth which we regard with any degree of attention. Those therefore that never have wings, but creep about till they die, may be considered as constituting the first class of insects. All these, the flea and the wood-louse only excepted, are produced from an egg; and, when once they break the shell, they never suffer any further change of form, but continue to grow larger till they die. The second order of insects consists of such as have wings: but which, when produced from the egg, have those wings cased up in such a manner as not to appear. The third order of insects is of the moth and butterfly kind. The fourth order is of those winged insects which come from a worm, instead of a caterpillar, and yet go through changes similar to those which moths and butterflies are seen to undergo. To these we add, as a fifth order, a numerous tribe lately discovered, to which naturalists have given the name of Zoophytes. These do not go through the ordinary forms of generation, but may be propagated by dissec-

tion. They seem a set of creatures placed between animals and vegetables, and form the link that connects animated and insensible nature.

"The structure of insects (says the author of the British Naturalist) is altogether a very curious matter, at least a matter different from those animal structures with which we are most familiar, and which we are, in consequence, apt to take as our standards. They are all *annulose* animals, that is, have their bodies divided across into a greater or smaller number of rings or segments. They are without a spine, or any thing like an internal skeleton, and thus the insertions of all the muscles, by which their parts are moved, are on the external covering, which is to them at once both skin and skeleton.

"That skin, though it do not contain, even in those that have it the hardest, carbonate of lime, like the crusts of crabs and lobsters, and the shells of oysters and snails, is yet more like a horny substance than the skin of those that we call the more perfect animals. The substance in the skin of the more perfect animals, which the covering of insects the most nearly resembles, is the epidermis, or scarfskin; and there is no appearance of vessels in its structure, or of a mucous net of true skin. In its composition, it is a good deal like horn, though it is not fibrous, like that substance. It also varies in hardness, being in some as hard as horn, and in others as flexible as leather; in some, too, it is elastic, and may be bent considerably and resume its form, while in others it is exceedingly brittle. The pincers, stings, claws, mandibles, and all the grasping, cutting, and piercing organs of insects, are formed of the same substance, though thickened and hardened where necessary, and also softened into pads and suckers where these are required; as on the feet of those insects which retain their hold upon polished surfaces,

and those that are perpendicular or inverted, without the aid of claws. All these, even to the minute hairs with which the bodies of insects are covered—as in those that form the fur of the mole cricket, are without any insertion of new substance, merely elongations of the general covering, by which means the delicate structure of the insect is kept together; and those that burrow in the earth, or bore into wood or stone, for the purpose of a dwelling for themselves, or a nidus for their offspring, never have the most delicate hair—even that which requires the assistance of a powerful microscope before it can be seen—abraded by the hard substances which they have to encounter. Those which burrow in the mud, too, even though their bodies be furry, seldom have the mud adhering to them; and those that are smooth have so exquisite a polish, that they are nearly proof against the action of the water. We are not aware, indeed, of any surface so perfectly smooth as that of the covering of some insects. This substance, also, admits of every degree of colour and transparency. The horny coats that protect the fixed eyes of insects from external injury, are, in some instances, as colourless as the air itself; while in other parts of them we meet with hues, which not only defy all the imitations of art, but are quite unrivalled among the works of nature. We also meet with an iridescence or play of colours, arising from the light being differently reflected; but, generally speaking, that is mere difference of reflection from the surface, and not refraction from the inner parts of the covering. It is the varying colour of the pigeon's neck, or of *shot* silk, and not that of a mother-of-pearl shell on an opal,—it arises from minute surfaces of different colours intermixed, and not from laminæ or plates, of different texture and transparency, placed the one over the other. In short, it is probably the most plastic, and therefore the

most curious substance in nature, being of all hues and all consistencies, and adaptable to all purposes; and yet in its composition always the same. It forms the fine down or feathers upon the moth and butterfly, the large nervous wings of the dragon-fly, the sting of the bee, the crust of the beetle; and it is very doubtful whether it does not also form the web of the spider, and even the cocoon of the silkworm.

"But there is a further uniformity of purpose in the muscular structure of insects—in those organs that move their little feet, their wings, their jaws, and their wonderful antennæ or feelers. Those muscles, downward as far as the microscope can follow them, are of the same fibrous texture as the muscles of large animals; but as they do not, like these, move over internal fulcrum bones, they are without tendons, and have their fibres inserted immediately into the covering or crust.

"The body of an insect was, by Linnæus, regarded as made up of three parts,—the head, the trunk, and the abdomen; but as the middle part, or trunk, consists of two distinct portions, more modern naturalists have considered the whole body as made up of four,—the head, the thorax, the breast, and the abdomen. The relative proportions of those parts, and also the mode and magnitude of the articulations, by which they are jointed to each other, differ much in the different species. The articulation of the head with the thorax can always be determined, and so can the division of the others, if not by the articulation, at least by the *annuli* or rings. Whatever may be their dimensions, or the mode in which they are joined together, the first ring behind the head is the thorax, the second the breast, and all the remainder, however many rings there may be, the abdomen.

"The head, as is the case with other animals, contains

the mouth and the organs of the senses: the only ones of which the functions or the plan is known with certainty, are the eyes, and the antennæ or feelers, which last are conceived to be more particularly organs of touch. The muscles that move the head take their rise near the abdominal extremity of the trunk, and have their insertion within the occipital opening. They are inserted in the direction towards which they move the head, and have their origin at the opposite side of the trunk, so that they cross the trunk inside diagonally; and they produce their motion by contraction, the same as the muscles of quadrupeds. In most insects the muscles that move the head downwards are more powerful than those that move it in any other direction.

"The thorax occupies the first ring of the trunk. It is in some species very small; but generally the centre of the under part of it is formed into a prominent *sternum*, or keel, and the fore legs are articulated to it—one on each side; and the upper part sometimes terminates backwards in a spine; with which the insect is capable of inflicting a wound.

"The breast forms the second and generally the largest ring of the trunk; but sometimes it and the thorax are so united, that only the depression between the two can be traced; and sometimes they are so loosely articulated, that the breast seems part of the abdomen. The upper part of the breast, which is that in which the principal muscles are inserted, is covered with a shield or *scutellum*, of a horny consistency. The imaginary death's head and cross bones are the bearings upon this shield in the *sphinx atropos*. The under part of this has a sternum or keel, as well as that of the thorax; to the sides of that, the two remaining pairs of legs, the middle and the hind ones, are articulated, and it sometimes covers the articulation and part of the first joint of the legs, and sometimes

shields some part of the abdomen. The wings are articulated to the breast, at the sides of the scutellum,—immediately to the sides of it in those that have not elytra or wing-covers, and in those that have, the wings and wing-covers are articulated to the abdominal edge and angles of the scutellum—so that when the wing-covers are raised, they separate from the scutellum as well as from each other at the middle.

"The abdomen occupies the rest of the body. It consists of a greater or smaller number of wings according to the genus of the insect; and the muscles by which it is moved are inserted in the breast, the same as those that move the head, and they pass diagonally in the same manner. Thus the trunk, and usually the breast, or second ring of the trunk, is the general fulcrum of motion for the whole body.

"The wings of insects are worthy of attention, not only from the beauty of their structure, and the nicety with which they are adapted to the other habits of the animal; but as they are a very convenient means of classing the animals.

"Most winged insects have four wings, though in all, the four are not of similar structure, or equally developed. The wings, which are the proper organs of flight, are constructed of a delicate network, of the horny substance which has been alluded to, upon which has been spread a thin membrane of the same. Frequently those membranous wings are covered over with feathers or scales, which also sometimes, as in the sphinx moth, cover other parts of the insect.

"The two upper wings are often horny and not adapted for flying, but they serve as a protection to the others. These are the elytra; and the insects which have them,—beetles, as they are indiscriminately called in common lan-

guage, are in the habit of creeping into, places where membranous wings would be in danger of being torn; or diving in water, where they would be rendered unfit for the purposes of flight. Even the membranous wings of insects, however strong in every thing but the scales with which some of them are covered, are much less liable to injury than one not acquainted with them would be apt to imagine.

"Sometimes the upper wings are only half the length, and adhere to the membranous ones that are below; and in many, the two under wings are not developed, but form a slender stalk behind each wing, ending in a knob. These organs are called *halteres* or balancers. It is doubtful, however, whether these ought, in all cases, to be considered as the rudiments of the second pair of wings, because they have been found wanting in some two-winged insects, and present in some four-winged ones, as in the *dytiscus marginalis*.

"The legs of insects consist of nearly the same distinct parts as those of larger animals. They are:—

"1. The hip *(coxa)*, which is immediately articulated to the side of the sternum.

"2. The thigh *(femur)*, which is articulated to the hip.

"3. The leg *(tibia)*, which is articulated to the thigh.

"4. The foot or toe *(tarsus)*, which consists of several joints, the first of them articulated to the leg, and the last to

"5. The claw *(unguis)*, which terminates the organ.

"The form and articulation of these are often exceedingly curious; but we find in them all that perfect harmony of organization and use, which can be so clearly traced in all the mechanism of animated nature, and which indeed forces itself upon our notice, whether we attempt to trace it or not. Thus, if the insect has only to walk and not to

leap, the thighs are slender; but when it has to leap, they are swelled out in breadth to afford room for the action of the muscles; and the swelling always takes place in that direction which is best calculated for giving ease and force to the motion. The articulation of the femur is equally well adapted to the habits of the insect. In some, the motion is most easy forwards, in others backwards, and in a considerable number it answers equally both ways.

"The tibia, too, is made to answer all the purposes of a simple leg; or it is lengthened, flattened, and fringed, that it may serve as an oar; or yet again it is made compact and firm, and toothed in the edge, so that it may form an engine for digging and cutting.

"The tarsus, or foot, varies very much, and exhibits a wonderful deal of mechanical contrivance, and a very nice adaptation of parts to the office that the organ has to perform. There is generally, whatever may be the number of joints or articulations in the part of the wing, a very strong flexor or contracting muscle, by means of which it is enabled to attach itself firmly to any substance.

"The claw is equally varied in its structure. Sometimes, as in the case of the mole cricket, it is in the form of a rake for hewing down and drawing along mud; at other times they are hooked claws, all bending in the same direction, by means of which it can suspend itself; sometimes again the claws act opposite to each other like a hand; and at other times there is but a single claw, to which a little protuberance on the tarsus serves as a thumb.

"Such are the outlines of the merely mechanical structure of insects. The other parts are equally curious, even those that are general to the class, and have no reference to the peculiar habits of any one. The nervous system, which is ramified from the brain, contained in the head; the singular formation that often is displayed in the mouth,

which is at one time a pump, and at another a pair of scissors; the complicated contrivance of cells and tubes, by which the blood is aërated; and, above all, the way in which nature has provided for the continuation of the species, with the long probation and singular changes through which many of them have to pass before they can enjoy the day or the hour which is given them to wanton in the beams of the sun. Taking them, diversified as they are among many genera and species, they form even in one corner of the smallest province of nature's kingdom ample and delightful study for the most active mind, through the most prolonged life.

"We are apt, because we cannot move from one part to another without labor, to associate interest with magnitude,—measure power with a line, and reckon wisdom by the tables of chronology; but when the work is His, 'with whom a thousand years are as one day, and one day as a thousand years,' we find also that space is not an element of the wonderful in His works; or time of the wisdom with which they have been made."

OF INSECTS WITHOUT WINGS.

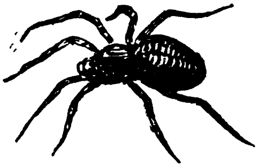
If we consider this class as distinct from others, we shall find them in general longer lived than the rest, and often continuing their term beyond one season, which is the ordinary period of an insect's existence. They seem also less subject to the influence of the weather; and often endure the rigors of winter without being numbed into torpidity. The whole race of moths, butterflies, bees, and flies, are rendered lifeless by the return of cold weather; but we need not be told, that the louse, the flea, and many of those wingless creatures that seemed formed to tease mankind, continue their painful depredations the whole year round.

They come to perfection in the egg, and it sometimes happens, that when the animal is interrupted in performing the offices of exclusion, the young ones burst the shell within the parent's body, and are thus brought forth alive. This not unfrequently happens with the wood-louse, and others of the kind, which are sometimes seen producing eggs, and sometimes young ones perfectly formed.

Though these creatures are perfect from the beginning, yet they are often, during their existence, seen to change their skin: this is a faculty which they possess in common with many of the higher ranks of animals, and which answers the same purposes. However tender their skins may seem to our feel, yet, if compared to the animal's strength and size, they will be found to resemble a coat of mail, or, to talk more closely, the shell of a lobster. By this skin these animals are defended from accidental injuries, and particularly from the attacks of each other; within this they continue to grow, till their bodies become so large as to be imprisoned in their own covering, and then the shell bursts, but is quickly replaced by a new one.

Lastly, these animals are endued with a degree of strength for their size, that at first might exceed credibility. Had man an equal degree of strength, bulk for bulk, with a louse or flea, the history of Samson would be no longer miraculous. A flea will draw a chain a hundred times heavier than itself; and, to compensate for this force, will eat ten times its own size of provision in a single day.

THE SPIDER.



THE animal that deserves our first notice in this principal order of insects is the Spider, whose manners are the most subtle, and whose instincts are most various. Formed for a life of rapacity, and incapable of living upon any other than insect food, all its habits are calculated to deceive and surprise; it spreads snares to entangle its prey; it is endued with patience to expect its coming; and is possessed of arms and strength to destroy it when fallen into the snare.

In these countries, where all the insect tribes are kept under by human assiduity, the Spiders are but small and harmless. We are acquainted with few but the HOUSE SPIDER, which weaves its web in neglected rooms; the GARDEN SPIDER, that spreads its web from tree to tree, and rests in the centre; the WANDERING SPIDER, that has no abode like the rest; and the FIELD SPIDER, which is sometimes seen mounting, web and all, into the clouds. These are the chief of our native Spiders; which, though reputed venomous, are entirely inoffensive. But they form a much more terrible tribe in Africa and America. In fact, the bottom of the MARTINICO SPIDER's body is as large as a hen's egg, and covered all over with hair. Its web is strong, and its bite dangerous.

Every Spider has two divisions in its body. The fore part, containing the head and breast, is separated from

the hinder part or belly by a very slender thread, through which, however, there is a communication from one part to the other. The fore part is covered with a hard shell, as well as the legs, which adhere to the breast. The hinder part is clothed with a supple skin, beset all over with hair. They have several eyes all round the head, brilliant and acute; these are sometimes eight in number, sometimes but six; two behind, two before, and the rest on each side. Like all other insects, their eyes are immoveable; and they want eyelids; but this organ is fortified with a transparent horny substance, which at once secures and assists their vision. As the animal procures its subsistence by the most watchful attention, so large a number of eyes was necessary to give it the earliest information of the capture of its prey. They have two pincers on the fore part of the head, rough, with strong points, toothed like a saw, and terminating in claws like those of a cat. A little below the point of the claw there is a small hole, through which the animal emits a poison, which, though harmless to us, is sufficiently capable of instantly destroying its prey. This is the most powerful weapon they have against their enemies; they can open or extend these pincers as occasion may require; and when they are undisturbed, they suffer them to lie one upon the other, never opening them but when there is a necessity for their exertion. They have all eight legs, joined like those of lobsters, and similar also in another respect; for if a leg be torn away, or a joint cut off, a new one will quickly grow in its place, and the animal will find itself fitted for combat as before. At the end of each leg there are three crooked moveable claws; namely, a small one, placed higher up, like a cock's spur, by the assistance of which it adheres to the threads of its web. There are two others larger, which meet together like a

lobster's claw, by which they can catch hold of the smallest depressions, walking up or down very polished surfaces, on which they can find inequalities that are imperceptible to our grosser sight. But when they walk upon such bodies as are perfectly smooth, as looking-glass or polished marble, they squeeze a little sponge, which grows near the extremity of their claws, and thus diffusing a glutinous substance, adhere to the surface until they make a second step. Besides the eight legs just mentioned, these animals have two others, which may more properly be called arms, as they do not serve to assist motion, but are used in holding and managing their prey.

The Spider, though thus formidably equipped, would seldom prove successful in the capture, were it not equally furnished with other instruments to assist its depredations. It is a most experienced hunter, and spreads its nets to catch such animals as it is unable to pursue. The Spider's web is generally laid in those places where flies are most apt to shelter. There the little animal remains for days, nay weeks together, in patient expectation, seldom changing its situation though ever so unsuccessful.

For the purposes of making this web, Nature has supplied this animal with a large quantity of glutinous matter, and five dugs or teats for spinning it into thread. This substance is contained in a little bag, and at first sight resembles soft glue; but when examined more accurately, it will be found twisted into many coils of an agate colour, and upon breaking it, the contents may be easily drawn out into threads, from the tenacity of the substance, not from those threads being already formed. Those who have seen the machine by which wire is spun, will have an idea of the manner in which this animal forms the threads of its little net, the orifices of the five teats

above mentioned, through which the thread is drawn, contracting or dilating at pleasure. The threads which we see, and appear so fine, are, notwithstanding, composed of five joined together, and these are many times doubled when the web is in formation.

When a House Spider proposes to begin a web, it first makes choice of some commodious spot, where there is an appearance of plunder and security. The animal then distils one little drop of its glutinous liquor, which is very tenacious, and then creeping up the wall, and joining its threads as it proceeds, it darts itself in a very surprising manner to the opposite place, where the other end of the web is to be fastened. The first thread thus formed, drawn tight, and fixed at each end, the Spider then runs upon it backward and forward, still assiduously employed in doubling and strengthening it, as upon its force depend the strength and stability of the whole. The scaffolding thus completed, the Spider makes a number of threads parallel to the first, in the same manner, and then crosses them with others; the clammy substance of which they are formed serving to bind them, when newly made, to each other.

The insect, after this operation, doubles and trebles the thread that borders its web, by opening all its teats at once, and secures the edges, so as to prevent the wind from blowing the work away. The edges being thus fortified, the retreat is next to be attended to; and this is formed like a funnel at the bottom of the web, where the little creature lies concealed. To this are two passages or outlets, one above and the other below, very artfully contrived, to give it an opportunity of making excursions at proper seasons, of prying into every corner, and cleaning those parts which are observed to be clogged or encumbered. Still attentive to its web, the Spider, from time to time,

cleans away the dust that gathers round it, which might otherwise clog and incommode it: for this purpose, it gives the whole a shake with its paws; still, however, proportioning the blow so as not to endanger the fabric. It often happens also, that from the main web there are several threads extended at some distance on every side: these are, in some measure, the outworks of the fortification, which, whenever touched from without, the Spider prepares for attack or self-defence. If the insect impinging be a fly, it springs forward with great agility; if, on the contrary, it be the assault of an enemy stronger than itself, it keeps within its fortress, and never ventures out till the danger be over. Another advantage which the Spider reaps from the contrivance of a cell, or retreat behind the web, is, that it serves for a place where the creature can feast upon its game with all safety, and conceal the fragments of those carcasses which it has picked, without exposing to public view the least trace of barbarity, that might create a suspicion in any insects that their enemy was near.

It often happens, however, that the wind, or the shaking of the supporters, or the approach of some large animal, destroys in a minute the labours of an age. In this case, the Spider is obliged to remain a patient spectator of the universal ruin; and when the danger is passed away, it sets about repairing the calamity. In general, the animal is much fonder of mending than making, as it is furnished originally with but a certain quantity of glutinous matter, which, when exhausted, nothing can renew. The time seldom fails to come, when their reservoirs are entirely dried up, and the poor animal is left to all the chances of irretrievable necessity. An old Spider is thus frequently reduced to the greatest extremity; its web is destroyed, and it wants the materials to make a new one. But as it has

been long accustomed to a life of shifting, it hunts about to find out the web of another Spider, younger and weaker than itself, with whom it ventures a battle. The invader generally succeeds; the young one is driven out to make a new web, and the old one remains in quiet possession. If, however, the Spider is unable to dispossess any other of its web, it then endeavours, for a while, to subsist upon accidental depredation; but in two or three months it inevitably dies of hunger.

The Garden Spider seems to work in a different manner. The method with this insect is to spin a great quantity of thread, which, floating in the air in various directions, happens, from its glutinous quality, at last to stick to some object near it, a lofty plant or the branch of a tree. The Spider only wants to have one end of the line fast, in order to secure and tighten the other. It accordingly draws the line when thus fixed, and then, by passing and repassing upon it, strengthens the thread in such a manner as to answer all its intentions. The first cord being thus stretched, the Spider walks along a part of it, and there fastens another; and, dropping thence, fastens the thread to some solid body below, then climbs up again and begins a third, which it fastens by the same contrivance. When three threads are thus fixed, it forms a square, or something that very nearly resembles one; and in this the animal is generally seen to reside. It oftens happens, however, when the young Spider begins spinning, that its web becomes too buoyant, and not only the thread floats in the air, but even the little spinster. In this manner we have often seen the threads of Spiders floating in the air; and, what is still more surprising, the young Spiders themselves attached to their own web.

The Spider's web being completed, and fixed in a proper place, its next care is to seize and secure whatever

insect happens to be caught in the toil. For this purpose, it sometimes remains for weeks, and even months, upon the watch, without even catching a single fly; for the Spider, like most other insects, is surprisingly patient of hunger. It occasionally happens that too strong a fly strikes itself against the web, and thus, instead of being caught, tears the net to pieces. In general, however, the butterfly or the hornet, when they touch the web, fly off again, and the Spider seems no way disposed to interrupt their retreat. The large bluebottle-fly, the ichneumon-fly, and the common meat-fly, seem to be its favourite game. When one of these strikes into the toils, the Spider is instantly seen alert and watchful at the mouth of its hole, careful to observe whether the fly be completely secured. If that be the case, the Spider walks leisurely forward, seizes its prey, and instantly kills it by instilling a venomous juice into the wound it makes. If, however, the fly be not fast, the Spider patiently waits, without appearing, until its prey has fatigued itself by its struggles to obtain its liberty; for if the ravager should appear in all his terrours, while the prey is but half involved, a desperate effort might give it force enough to get free. If the Spider has fasted for a long time, it then drags the fly immediately into its hole and devours it; but if there have been plenty of game, and the animal be no way pressed by hunger, it then gives the fly two or three turns in its web, so as completely to secure it, and there leaves it impotently to struggle until the little tyrant comes to its appetite.

It has been the opinion of some philosophers that the Spider is in itself both male and female; but Lister has been able to distinguish the sexes, and to perceive that the males are much less than the females.

The female generally lays from nine hundred to a thou-

sand eggs in a season. These eggs are large or small in proportion to the size of the animal that produces them. In some they are as large as a grain of mustard seed; in others, they are scarcely visible. The female never begins to lay till she is two years old.

When the number of eggs which the Spider has brought forth have remained for an hour or two to dry after exclusion, the little animal then prepares to make them a bag, where they are to be hatched, until they leave the shell. For this purpose, she spins a web four or five times stronger than that made for catching flies; and, besides, lines it withinside with down, which she plucks from her own breast. This bag, when completed, is as thick as paper, is smooth withinside, but rougher without. Within this they deposit their eggs; and it is almost incredible to relate the concern and industry which they bestow in the preservation of it. They stick it by means of their glutinous fluid to the end of their body; so that the animal, when thus loaded, appears as if she had one body placed behind another. If this bag be separated from her by any accident, she employs all her assiduity to stick it again in its former situation, and seldom abandons her treasure but with her life. When the young ones are excluded from their shells, within the bag, they remain for some time in their confinement, until the female, instinctively knowing their maturity, bites open their prison, and sets them free. But her parental care does not terminate with their exclusion; she receives them upon her back for some time, until they have strength to provide for themselves, when they leave her, never to return, and each begins a separate manufactory of its own. The young ones begin to spin when they can scarcely be discerned; and prepare for a life of plunder before they have strength to overcome.

Thus there is no insect to which they are not enemies; but, what is more barbarous still, Spiders are the enemies of each other. Reaumur, who was fond of making experiments upon insects, tried to turn the labours of the Spider to human advantage, and actually made a pair of gloves from their webs. For this purpose, he collected a large number of those insects together: he took care to have them constantly supplied with flies, and the ends of young feathers, fresh picked from chickens and pigeons, which, being full of blood, are the diet that Spiders are particularly fond of. But, notwithstanding all his care, he was soon convinced that it was impracticable to rear them, since they were of such a malignant nature that they could never be brought to live in society; but, instead of their usual food, chose to devour each other. Indeed, were it practicable to reconcile them to each other, it would require too much attendance to rear up a sufficient number to make the project any way useful. Their thread is four or five times finer than that of the silkworm; so that, upon the smallest calculation, there must have been sixty thousand Spiders to make a single pound of silk. That which Reaumur made use of was only the web in which they deposited their eggs, which is five times stronger than their ordinary manufacture.

Of this animal there are several kinds, slightly differing from each other either in habits or conformation. The Water Spider is the most remarkable of the number. This insect resembles the common Spider in its appearance, except that its hinder part is made rather in the shape of a ninepin than a ball. They differ in being able to live as well by land as water, and in being capable of spinning as well in one element as the other. Their appearance under water is very remarkable; for, though they inhabit the bottom, yet they are never touched by the

element in which they reside, but are enclosed in a bubble of air, that, like a box, surrounds them on every side. This bubble has the bright appearance, at the bottom, of quicksilver; and within this they perform their several functions of eating, spinning, and sleeping, without its ever bursting, or in the least disturbing their operations.

THE TARANTULA

Is also of this species, and deserves particular notice, only for the numerous falsehoods which have been propagated concerning it. What may be said with truth concerning it is, that it is the largest of the Spider kind known in Europe, and is a native of Apulia, in Italy. Its body is three quarters of an inch long, and about as thick as a man's little finger; the colour is generally an olive brown, variegated with one that is more dusky; it has eight legs and eight eyes, like the rest, and nippers, which are sharp and serrated; between these and the fore legs there are two little horns, or feelers, which it is observed to move very briskly when it approaches its prey. It is covered all over the body with a soft down; and propagates, as other Spiders, by laying eggs. In the summer months, particularly in the dogdays, the Tarantula, creeping among the corn, bites the mowers and passengers; but in winter it lurks in holes, and is seldom seen.

Thus far is true; but now the fable begins: for though the bite is attended with no dangerous symptoms, and will easily cure of itself, wonderful stories are reported concerning its virulence. At first the pain is scarcely felt; but a few hours after, a violent sickness is said to come on, with difficulty of breathing, fainting, and sometimes trembling. The person bit, after this, does nothing but laugh, dance, and skip about, putting himself into the most extravagant postures; and sometimes also is seized with a most frightful melancholy. At the return of the season in which he was bit, his madness begins again; and the patient always talks of the same things. Sometimes he fancies himself a shepherd, sometimes a king: these troublesome symptoms sometimes return for several years successively, and at last terminate in death. But so dreadful a disorder has, it seems, not been left without a remedy, which is no other than a well played fiddle. For this purpose the medical musician plays a particular tune, famous for the cure, which he begins slow, and increases in quickness as he sees the patient affected. The patient no sooner hears the music than he begins to dance; and continues so doing till he is all over in a sweat, which forces out the venom that appeared so dangerous. Such are the symptoms related of the Tarantula poison; but the truth is, that the whole is an imposition of the peasants upon travellers who happen to pass through that part of the country, and who procure a trifle for suffering themselves to be bitten by the Tarantula. Whenever they find a traveller willing to try the experiment, they readily offer themselves; and are sure to counterfeit the whole train of symptoms which music is said to remove. It is thus that falsehoods prevail for a century or two; and mankind at last begin to wonder how it was possible to keep up the delusion so long.

THE GREAT AMERICAN SPIDER.

This is one of the largest species of the tribe. Its ba is covered with a hard, thick, brown coat, hollowed at t sides, and cleft transversely across the middle, as if it h a hole in that place. The head is small, and with difficu distinguished from the corslet. The mouth is furnished wi brown, hard, crooked teeth: the body is large and roun growing out into two parts. Except the back, the who body and the feet are covered with long bushy hair. Th extremities of the feet are smooth and large, like the to of a dog.

This hideous species of the Spider tribe preys principall on small birds: in doing of which, it tears them to piece to get at their blood, and afterwards sucks their egg

THE BARBARY SPIDER.

This species is as large as a man's thumb, and is a nati of Barbary. It inhabits hedges and thickets: its webs hav large meshes, and it resides in the centre upon its nest. Th snares are spread for large flies, wasps, drones, and even locusts. The animal which it entangles is soon killed by the Spider, and partly eaten if the Spider be hungry; the rest is concealed under some neighbouring dry leaves, covered with a kind of web, and a blackish glue in great abundance. Its larder is often plentifully stored. Its nest is about the size of a pullet's egg, divided horizontally, and suspended by the threads of the insect, which are of a silvery white, and stronger than silk. It carries its eggs in a little bag under its belly, from which the young ones come out, and for a time live in the same web in amity; but, when grown up, are mortal enemies. Whenever they meet they fight furiously, and the battle ends only with the death of the weakest; whose dead body is carefully stored away in the larder.

THE FLEA.

The history of those animals with which we are best acquainted is one of the first objects of our curiosity. If the Flea be examined with a microscope, it will be observed to have a small head, large eyes, and a roundish body. It has two feelers, or horns, which are short, and composed of four joints; and between these lies its trunk, which it buries in the skin, and through which it sucks the blood in large quantities. The body appears to be all over curiously adorned with a suit of polished sable armour, neatly joined, and beset with multitudes of sharp pins, almost like the quills of a porcupine. It has six legs, the joints of which are so adapted that it can, as it were, fold them up one within another; and when it leaps, they all spring out at once, whereby its whole strength is exerted, and the body raised above two hundred times its own diameter.

The young Fleas are at first a sort of nits or eggs, which are round and smooth; and from these proceed white worms, of a shining pearl colour: in a fortnight's time they come to a tolerable size, and are very lively and active; but if they are touched at this time, they roll themselves up in a ball: soon after this they begin to creep like silkworms that have no legs; and then they seek a place to lie hid in, where they spin a silken thread from their mouth, and with this they enclose themselves in a

small round bag or case, as white within as writing pap but dirty without: in this they continue for a fortnight lon er; after which they burst from their confinement perfec ly formed, and armed with powers to disturb the peace an emperor.

THE LOUSE.

In examining the *human Louse* with the microscope, external deformity first strikes us with disgust: the sha of the fore part of the head is somewhat oblong; that the hind part somewhat round: the skin is hard, and, bein stretched, transparent, with here and there several bristl hairs: in the fore part is a proboscis or sucker, which seldom visible: on each side of the head are antennæ o horns, each divided into five joints, covered with bristly hair; and several white vessels are seen through thes horns: behind these are the eyes, which seem to wan those divisions observable in other insects, and appear en compassed with some few hairs: the neck is very shor and the breast is divided into three parts: on each side o which are placed six legs, consisting of six joints covered also with bristly hairs: the ends of the legs are armed with two smaller and larger ruddy claws, serving those insects as a finger and thumb, by which they catch hold of such objects as they approach: the end of the body terminates in a cloven tail, while the sides are all over hairy; the whole resembling clear parchment, and, when roughly pressed, cracking with a noise.

When we take a closer view, its white veins, and other internal parts, appear; as likewise a most wonderful motion in its intestines, from the transparency of its external covering. When the Louse feeds, the blood is seen to rush, like a torrent, into the stomach: and its greediness is so great, that the excrements contained in the intestines

e ejected at the same time, to make room for this new pply.

The Louse has neither beak, teeth, nor any kind of mouth. n the place of all these, it has a proboscis or trunk; or, s it may be otherwise called, a pointed hollow sucker, ith which it pierces the skin, and sucks the human blood, king that for food only. The stomach is lodged partly in e breast and back; but the greatest portion of it is in e abdomen. When it is empty, it is colourless; but hen filled, it is plainly discernible, and its motion seems ery extraordinary. It then appears working with very trong agitations, and somewhat resembles an animal withn an animal. Superficial observers are apt to take this for he pulsation of the heart; but if the animal be observed when t is sucking, it will be found that the food takes a direct passage from the trunk to the stomach, where the remainder of the old aliment will be seen mixing with the new, and agitated up and down on every side.

If this animal be kept from food two or three days, and hen placed upon the back of the hand, or any soft part of he body, it will immediately seek for food; which it will the more readily find, if the hand be rubbed till it grows red. The animal then turns its head, which lies between the two fore legs, to the skin, and diligently searches for some pore: when found, it fixes the trunk therein; and soon the microscope discovers the blood ascending through the head, in a very rapid, and even frightful stream. The Louse has at that time sufficient appetite to feed in any posture; it is then seen sucking with its head downward, and its tail elevated. If, during this operation, the skin be drawn tight, the trunk is bound fast, and the animal is incapable of disengaging itself; but it more frequently suffers from its gluttony, since it gorges to such a degree, that it is crushed to peices by the slighest impression.

There is scarcely any animal that multiplies so fast a this unwelcome intruder. It has been pleasantly said, th a Louse becomes a grandfather in the space of twenty- four hours: this fact cannot be ascertained; but nothing i more true than, that the moment the nit, which is no othe than the egg of the Louse, gets rid of its superfluous moi ture, and throws off its shell, it then begins to breed in i turn. Nothing so much prevents the increase of this na seous animal, as cold and want of humidity; the nits mu be laid in a place that is warm, and moderately moist, t produce any thing. That is the reason that many nits lai on the hairs in the night time, are destroyed by the cold o the succeeding day, and so stick for several months, til they at last come to lose even their external form. S numerous were the disgusting vermin in Mexico, that the ancient monarchs of that country endeavoured to rid the subjects of them by imposing an annual tribute of a certain quantity. Bags full of Lice were found in Montezuma's palace by the Spanish invaders.

There is scarce an animal, and scarce even a vegetable that does not suffer under its own peculiar Louse. The sheep, the horse, the hog, and the elephant, are all teased by them; the whale, the shark, the salmon, and the lobster, are not without their company; while every hot-house and every garden is infested with some peculiarly destructive. Linnæus tells us, that he once found a Vegetable Louse upon some plants newly arrived from America; and willing to trace the little animal through its various stages, he brought it with him from London to Leyden, where he carefully preserved it during the winter, until it bred in the spring: but the Louse it seems did not treat him with all the gratitude he expected: for it became the parent of so numerous a progeny, that it soon overrun all the physic garden of that beautiful city; and leaves, to this day, many a gardener to curse the Swede's too indulgent curiosity.

The APHIS,which some have called the LEAF LOUSE, or PLANT LOUSE, is of the size of a flea, and of a bright green, or bluish green colour; the body is nearly oval, and is largest and most convex on the hinder part: the breast is very small, and the head is blunt and green; the eyes may be seen very plainly, being prominent on the fore part of the head, and of a shining black colour; near these there is a black line on each side; and the legs are very slender.

Almost every plant has its species of this animal; and the weaker the leaves and buds are, these insects swarm upon them in greater abundance. Some plants are covered over with them; though they are not the cause of the plant's weakness, but the sign: however, by wounding and sucking the leaf, they increase the disease. They generally assume their colour from the plant on which they reside. Those that feed upon pot-herbs and plum trees are of an ash colour; only they are greenish when they are young: those that belong to the alder and cherrytree, are black; as also those upon beans, and some other plants: those on the leaves of apples are white. As they leap, like grasshoppers, some place them in the number of the flea kind. The most uncommon colour is reddish; and Lice of this sort may be found on the leaves of tansy; and their juice, when rubbed on the hands, tinges them with no disagreeable red. All these live upon their respective plant; and are often engendered within the very substance of the leaf.

In spring they are viviparous, producing the young alive; in the autumn, and towards winter, when a warm covering and tenderer nursing seem to be necessary, they are oviparous. By a strange deviation from the usual laws of nature, one impregnation of the female suffices for many successive generations without farther aid from the male. The fœtus, when it is ready to be brought forth,

entirely fills the belly of the female; its fore part being excluded first, and then the hinder. The young one does not begin to move till the horns or feelers appear out of the body of the old one; and by the motion of these it first shows signs of life, moving them in every direction, and bending all their joints. When the horns and head are excluded, the two fore feet follow, which they move with equal agility; after this follow the middle feet, and then the hinder: still, however, the young one continues sticking to its parent, supported only at one extremity, and hanging as it were in air, until its small and soft members become hardened and fitted for self-support. The parent then gets rid of its burthen; by moving from the place where she was sitting, and forcing the young one to stand upon its legs, she leaves it to shift for itself.

As the animal has not far to go, its provision lying beneath it, during the summer it continues to eat and creep about with great agility. But as it is viviparous, and must necessarily lurk somewhere in winter, where its body may be defended from the cold, it endeavors to secure a retreat near the trees or plants that serve to nourish it in the beginning of spring. They never hide themselves in the earth, like many other insects, because they have no part of their bodies fitted to remove the earth; nor can they creep into every chink, as their legs are too long: besides, their bodies are so tender, that the least rough particle of the earth would hurt them. They therefore get into the deep chinks of the bark, and into the cavities of the stronger stalks, whence they sally out upon the branches and leaves, when the warmth of the sun begins to be felt. Neither the cold in the autumnal season, nor the lesser degree of heat in the spring, ever hurts them; they seldom, therefore, seek for hiding-places before the fall of the leaf, and are alert enough to take the earliest advantage of the returning spring.

Like many other insects, they cast their skins four several times; and, what is very remarkable, the males have four wings, but the females never have any. They all have long legs, not only to enable them to creep over the long hairs of plants and leaves, but also to travel from one tree to another, when they happen to stand at a distance. Their trunk or snout lies under their breast; and this they thrust into the pores of the plant to suck out the juice, for they do not gnaw them, like the caterpillar; but so hurt them by sucking, that the leaves become spotted, and as it were overrun with scabs; for which reason their edges always turn up towards the middle.

It has been said, that these insects are often carried away and devoured by ants; but this is an erroneous idea. It is true that the Aphis is sometimes carried away by the ant, but it is for quite another purpose than that of being devoured. Among the wonders of the ant tribe is that of their keeping and feeding certain insects, from which they extract a sweet and nutritious liquid, in the same manner as we obtain milk from cows. The Aphides, or Plant Lice, and the gall insects, are those which are selected for this purpose. "Linnæus, and after him other naturalists (says the author of the Natural History of Insects) have called these the milch cattle of the ants; and the term is not inapplicable. In the proper season, any person, who may choose to be at the pains of watching their proceedings, may see, as Linnæus says, the ants ascending trees that they may milk their cows, the Aphides. The substance which is here called milk is a saccharine fluid, which these insects secrete; it is scarcely inferior to honey in sweetness, and issues in limpid drops from the body of the insect, by two little tubes, placed one on each side just above the abdomen. The Aphides insert their suckers into the tender bark of a tree, and employ themselves without intermission in ab-

sorbing its sap; which, having passed through the digestive organs of the insect, is discharged by the organs just described. When no ants happen to be at hand to receive this treasure, the insects eject it to a distance by a jerking motion, which at regular intervals they give their bodies. When the ants, however, are in attendance, they carefully watch the emission of this precious fluid, and immediately suck it down. The ants not only consume this fluid when voluntarily ejected by the Aphides, but, what is still more surprising, they know how to make them yield it at pleasure; or, in other terms, to milk them. On this occasion the antennæ of the ants discharge the same functions as the fingers of a milkmaid: with these organs, moved very rapidly, they pat the abdomen of an Aphis first on one side and then on the other: a little drop of the much coveted juice immediately issues forth, which the ant eagerly conveys to its mouth. The milk of one Aphis having been thus exhausted, the ant proceeds to treat others in the same manner, until at length it is satiated, when it returns to its nest.

"A still more singular fact, connected with this branch of the natural economy of these insects, remains to be stated. These cows are not always considered the common property of a whole tribe; on the contrary, some of them are appropriated to the exclusive use of the inhabitants of a particular hill or nest; and to keep these cows to themselves, they exert all their skill and industry. Sometimes the Aphides inhabiting the branches of a particular tree, or the stalks of a particular plant, are thus appropriated; and if any vagrant foreigners attempt to share this treasure with its true owners, the latter, exhibiting every symptom of uneasiness and anger, employ all their efforts to drive them away.

"Some species of ants go in search of these Aphides on

the vegetables where they feed; but there are others, as the yellow ant, which collect a large herd of a kind of Aphis, which derives its nutriment from the roots of grass and other plants. These milch kine they remove from their native plants and domesticate in their habitations, affording, as Huber justly observes, an example of almost human industry and sagacity. On turning up the nest of the yellow ant, this naturalist one day saw a variety of Aphides either wandering about in the different chambers, or attached to the roots of plants which penetrated into the interior. The ants appeared to be extremely jealous of their stock of cattle; they followed them about, and caressed them, whenever they wished for the honied juice, which the Aphis never refused to yield. On the slightest appearance of danger, they took them up in their mouths, and gently removed them to a more sheltered and more secure spot. They dispute with other ants for them, and in short watch them as keenly as any pastoral people would guard the herds which form their wealth. Other species which do not gather the Aphides together in their own nest, still seem to look on them as private property; they set sentinels to protect their places of resort, and drive away other ants; and, what is still more extraordinary, they enclose them as a farmer does his sheep, to preserve them not only from rival ants, but also from the natural enemies of the Aphis.

"If the branch on which the Aphides feed be conveniently situated, the ants have recourse to a very effectual expedient to keep off all trespassers: they construct around the branch containing the Aphides a tube of earth, or some other material, and in this enclosure, formed over the nest, and generally communicating with it, they secure their cattle against all interlopers. The brown ant has been observed by Huber to build a chamber round the stem of

a thistle, in such a way, that the stalk passed through the centre, so that from their ant hill they had only to climb the thistle stalk, in order to enter this cattle fold, which was suspended in mid air. The interior, smooth and compact, was entirely formed of earth; it contained an extensive family of insect cows, sheltered from the inclemencies of the weather, and protected from their enemies.—To this must be added, that not only is the full grown animal kept, but its eggs are watched and guarded with that care which warrant us in supposing that the ant knows their full value. The eggs are deposited in the warmest part of the dwelling, to facilitate their early hatching."

These insects have many enemies, but the four principal and constant are, first, the fire-fly, which lays its eggs where these insects are in greatest numbers, which producing a worm, seizes and devours all the Leaf Lice that come near it: another enemy is the worm of a peculiar kind of beetle, which destroys them in great numbers: a third is the larva of the lady bird: but the most formidable of all enemies, is the ichneumon fly, that seizes upon one of the largest females, and laying its egg upon her, this is hatched into a worm, which soon devours and destroys the animal from whose body it sprung.

THE BUG

Is another of those nauseous insects that intrude upon the retreats of mankind; and often banish that sleep, which even sorrow and anxiety permitted to approach. This, to many men, is of all insects the most troublesome and obnoxious. The night is usually the season when the wretched have rest from their labor: but this seems the only season when the Bug issues from its retreats, to make its depredations. By day it lurks, like a robber, in the most secret parts of the bed; takes the advantage of every chink

and cranny, to make a secure lodgement; and contrives its habitation with so much art, that scarce any industry can discover its retreat. It seems to avoid the light with great cunning; and even if candles be kept burning, this formidable insect will not issue from its hiding place. But, when darkness promises security, it then issues from every corner of the bed, drops from the tester, crawls from behind the arras, and travels, with great assiduity, to the unhappy patient, who vainly wishes for rest and refreshment. It is generally vain to destroy one only, as there are hundreds more to revenge their companion's fate; so that the person who thus is subject to be bitten remains the whole night, like a sentinel upon duty, rather watching the approach of fresh invaders, than inviting the pleasing approach of sleep.

Nor are these insects less disagreeable from their nauseous stench, than their unceasing appetite. When they begin to crawl, the whole bed is infected with the smell; but if they are accidentally killed, then it is insupportable.

These are a part of the inconveniences that result from the persecution of these odious insects; but, happily for Great Britain, they multiply less in that island than in any part of the continent. They are said to have been introduced there in the fir timber which was brought over to rebuild London, after the fire of 1666. In France and Italy, the beds, particularly in their inns, swarm with them; and every piece of furniture seems to afford them a retreat. They grow larger also with them than in England, and bite with more cruel appetite.

This animal, if examined minutely, appears to consist of three principal parts; the head, the corslet, and the belly. It has two brown eyes, that are very small and a little prominent, besides two feelers with three joints: underneath these, there is a crooked trunk, which is its instru-

ment of torture, and which, when not in motion, lies close upon the breast. The breast is a kind of ring; in which are placed the two first pairs of legs. The belly consists of nine rings; under which are placed the two pairs of legs more, making six in all. Each leg has three joints, which form the thigh, the leg, and the foot, which is armed with a crooked claw, like a hook. The body is smooth except a few short hairs, that may be seen by the microscope, about the vent, and on the two last rings. Its sight is so exquisite, that the instant it perceives the light it generally makes good its retreat; and they are seldom caught, though the bed swarms with them.

Cleanliness seems to be the best antidote to remove these nauseous insects; and wherever that is wanting, their increase seems but a just punishment. Indeed, they are sometimes found in such numbers among old furniture, and neglected chambers, exposed to the south, that wanting other sustenance, they devour each other. They are also enemies to other vermin, and destroy fleas very effectually; so that we seldom have the double persecution of different vermin in the same bed. Of the Bug kind Linnæus reckons up forty.

THE SURINAM BUG.

The genus to which this belongs is divided into different sections, the whole number of species being above one

hundred. The common bed Bug has no wings; but the field Bugs all have wings, and inhabit plants as various as their shape and colour. The Surinam Bug, thus named by Madame Merian, who first discovered this frightful insect at Surinam, and figured it from life in her inimitable collection, from which our figure is taken, is the largest known species of the cimex tribe, measuring three inches and a half from head to tail, and six inches in circumference. It is of a rich brown colour, armed with a single sharp spine on the head, and another at the anus; the eyes are black and very prominent; there are two large dark brown spots on the thorax, about the size of peas; two others more oblong behind; and others of various forms and sizes on the fore legs; the elytra are reticulated with white, and are very thick and strong; the interior wings are membranaceous, and of a delicate straw colour. This is not only the largest, but the most destructive and voracious, of the genus, attacking and devouring, in its creeping state, toads, frogs, lizards, aquatic insects, and even fish; and, in its winged state, preying upon reptiles, birds, and the larger animals, and even on the weaker individuals of its own family.

THE COMMON WOOD LOUSE

Is seldom above half an inch long, and a quarter of an inch broad. The colour is of a livid black, especially when found about dunghills, and on the ground: but those that are to be met with under tiles, and in drier places, are of the colour of the hair of an ass. It has fourteen feet, seven on each side; and they have only one joint each, which is scarcely perceivable. It has two short feelers; the body is of an oval shape; and the sides, near the feet, are dentated like a saw. When it is touched, it rolls itself up in a sort of ball. It is often found among rotten

timber, and on decayed trees: in winter it lies hid in the crevices of walls, and all sorts of buildings. The male is easily distinguishable from the female, being less, and more slender. The eggs they lay are white and shining, like seed pearls, and are very numerous; more properly speaking, however, when excluded, the young have all the appearance of an egg, yet they are alive, and, without throwing off any shell, stir and move about with great vivacity; so that this animal may properly be said to be viviparous. The little worms at first seem scarcely able to stir; but they soon feed, and become very brisk. Of this insect Linnæus makes three species.

THE MONOCULUS, OR ARBORESCENT WATER FLEA.

This animal, which is of the size of a Flea, appears to the sight, unassisted by the microscope, to have but one eye; for the eyes, by reason of the smallness of the head, seem to be joined to each other: they are situated in the trunk of this insect, and the beak is likewise very small and sharp pointed. The structure of the eye is seen by the microscope to be reticulated, or made like a net; and the trunk of the insect, by which it feeds, is not only small and sharp, but also transparent. The insects are of a blood red colour; and sometimes are seen in such multitudes on the surface of standing water, as to make it appear all over red, whence many fanciful people have thought the water to be turned into blood.

Of all the parts of this animal, its branching arms, and the motion it makes with them in the water, deserve our greatest attention. By these the little creature can move in a straight line; waving its arms, as a bird does its wings in the air, sometimes upward, sometimes downward, sometimes to the right, sometimes to the left, yet still continu-

ing to proceed in a right line. By striking the water with its arms, it can ascend with great velocity; and by striking in a contrary direction, it dives with equal ease. As these motions are very rapid, the little animal appears to jump in the water, its head always tending to the surface, and its tail stretched downward. When a number of them are gamboling on a pool in the sun, the glitter of their wing cases makes them look like sparks of fire. This insect is produced from an egg, which, when excluded, is carried on the back of the female, and soon is seen floating in the water round her. Its appearance at first is that of a very small whitish insect, endued with a very nimble motion. Except in colour, it suffers no change, only continuing to grow larger and redder, as it grows old. They sometimes remain several days on the surface of the water, and sometimes are seen at the bottom only; but they are never at rest. They change their skin, like most other insects; and the cast skin resembles the insect itself so exactly, that one might mistake the mask for the animal.

THE SCORPION.

There is scarcely an insect without wings that is not obnoxious to man: the smallest have the power of annoying him, either by biting or stinging him; and though each is in itself contemptible, they become formidable from their

numbers. But of all this class, there is none so terrible as the Scorpion, whose shape is hideous, whose size among the insect tribe is enormous, and whose sting is generally fatal.

The Scorpion is one of the largest of the insect tribe, and not less terrible from its size than its malignity. It resembles a lobster somewhat in shape, but is infinitely more hideous. There have been enumerated nine different kinds of this dangerous insect, chiefly distinguished by their colour: there being Scorpions yellow, brown, and ash coloured; others that are the colour of rusty iron, green, pale yellow, black, claret colour, white, and gray.

There are four principal parts distinguishable in this animal: the head, the breast, the belly, and the tail. The Scorpion's head seems, as it were, joined to the breast; in the middle of which are seen two eyes; and a little more forward, two eyes more, placed in the fore part of the head: these eyes are so small, that they are scarcely perceivable; and it is probable the animal has but little occasion for seeing. The mouth is furnished with two jaws; the undermost is divided into two, and the parts notched into each other, which serves the animal as teeth, and with which it breaks its food, and thrusts it into its mouth: these the Scorpion can at pleasure pull back into its mouth, so that no part of them can be seen. On each side of the head are two arms, each composed of four joints; the last of which is large, with strong muscles, and made in the manner of a lobster's claw. Below the breast are eight articulated legs, each divided into six joints; the two hindmost of which are each provided with two crooked claws, and here and there covered with hair. The belly is divided into seven little rings; from the lowest of which is continued a tail, composed of six joints, which are bristly, and formed like little globes, the last being armed with a

crooked sting. This is that fatal instrument which renders this insect so formidable: it is long, pointed, hard, and hollow; it is pierced near the base by two small holes, through which, when the animal stings, it ejects a drop of poison, which is white, caustic, and fatal. The reservoir in which this poison is kept, is a small bladder near the tail, into which the venom is distilled by a peculiar apparatus. If this bladder be gently pressed, the venom will be seen issuing out through the two holes above mentioned; so that it appears, that when the animal stings, the bladder is pressed, and the venom issues through the two apertures into the wound.

There are few animals more formidable, or more truly mischievous, than the Scorpion. As it takes refuge in a small place, and is generally found sheltering in houses, so it cannot be otherwise than that it must frequently sting those among whom it resides. In some of the towns of Italy, and in France, in the province of Languedoc, it is one of the greatest pests that torment mankind; but its malignity in Europe is trifling, when compared to what the natives of Africa and the East are known to experience. In Batavia, where they grow twelve inches long, there is no removing any piece of furniture, without the utmost danger of being stung by them.

Bosman assures us that, along the Gold Coast, they are often found larger than a lobster; and that their sting is inevitably fatal. In Europe, the general size of this animal does not exceed two or three inches; and its sting is very seldom found to be fatal. Maupertius, who made several experiments on the Scorpion of Languedoc, found it by no means so invariably dangerous as it had till then been represented.

From his experiments, indeed, it appears that many circumstances, which are utterly unknown, must contribute

to give efficacy to the Scorpion's venom; but whether its food, long fasting, the season, the nature of the vessels it wounds, or its state of maturity, contribute to or retard its malignity, is yet to be ascertained by succeeding observers.

The Scorpion of the tropical climates being much larger than the former, is probably much more venomous. Helbigius, however, who resided many years in the East, assures us, that he was often stung by the Scorpion, and never received any material injury from the wound: a painful tumour generally ensued; but he always cured it by rubbing the part with a piece of iron or stone, as he had seen the Indians practise before him, until the flesh became insensible. Seba, Moore, and Bosman, however, give a very different account of the scorpion's malignity; and assert that, unless speedily relieved, the wound becomes fatal.

It is certain that no animal in the creation seems endued with such an irascible nature.

Volckammer tried the courage of the Scorpion against the large spider, and enclosed several of both kinds in glass vessels for that purpose.* The success of this combat was very remarkable. The spider at first used all its efforts to entangle the Scorpion in its web, which it immediately began spinning; but the Scorpion rescued itself from the danger by stinging its adversary to death: it soon after cut off, with its claws, all the legs of the spider, and then sucked all the internal parts at its leisure. If the Scorpion's skin had not been hard, Volckammer is of opinion that the spider would have obtained the victory; for he had often seen one of these spiders destroy a toad.

The fierce spirit of this animal is equally dangerous to

* Ephemerides, Dec. 11, 1687. Observ. 224.

own species; for Scorpions are the cruelest enemies to ch other. Maupertius put about a hundred of them to-ther in the same glass; and they scarcely came into con-ct, when they began to exert all their rage in mutual de-truction: there was nothing to be seen but one univer-l carnage, without any distinction of age or sex; so that, a few days, there remained only fourteen, which had lled and devoured all the rest.

But their unnatural malignity is still more apparent, in heir cruelty to their offspring. He enclosed a female Scorpion, big with young, in a glass vessel, and she was een to devour them as fast as they were excluded; there as but one of the whole number that escaped the gene-al destruction, by taking refuge on the back of its parent; and this soon after revenged the cause of its brethren, by killing the old one in its turn.

Were it worth the trouble, these animals might be kept living as long as curiosity should think proper. Their chief food is worms and insects; and, upon a proper supply of these, their lives might be lengthened to their natural extent. How long that may be we are not told; but if we may argue from analogy, it cannot be less than seven or eight years; and, perhaps, in the larger kind, double that duration. As they have somewhat the form of the lobster, so they resemble that animal in casting their shell, or more properly, their skin; since it is softer by far than the cover-ing of the lobster, and set with hairs; which grow from it in great abundance, particularly at the joinings. The young lie in the womb of the parent, each covered up in its own membrane, to the number of forty or fifty, and uni-ted to each other by an oblong thread, so as to exhibit al-together the form of a chaplet.

There is, however, a Scorpion of America, produced from the egg, in the manner of the spider. The eggs

are no larger than pins' points; and they are deposit in a web, which they spin from their bodies, and car about with them till they are hatched. As soon as th young ones are excluded from the shell, they get up the back of the parent, who turns her tail over them, a defends them with her sting. It seems probable, therefo that captivity produces that unnatural disposition in th Scorpion, which induces it to destroy its young; since, liberty, it is found to protect them with such unceasi assiduity.

THE SCOLOPENDRA AND GALLY-WORM.

Of these hideous and angry insects we know little, excep the figure and the noxious qualities. Though with u there are insects somewhat resembling them in form we are placed at a happy distance from such as ar really formidable. With us they seldom grow abov an inch long; in the tropical climates they are often found above a quarter of a yard.

The Scolopendra is otherwise called the *Centipe*, from the number of its feet; and it is very common in many parts of the world, especially between the tropics. Those of the East Indies, where they grow to the largest size, and are sometimes more than a foot in length, are of a ruddy colour, and as thick as a man's finger; they consist of many joints; and from each joint is a leg on each side: they are covered with hair, and seem to have no eyes; but there are two feelers on the head, which they make use of to find out the way they are to pass: the head is very round, with two small sharp teeth, with which they inflict wounds that are very painful and dangerous. A sailor that was bit by one on board a ship, felt an excessive pain, and his life was supposed to be in danger: however, he re-

vered, by the application of three roasted onions to the rt; and was soon quite well. Of this animal there e different kinds: some living, like worms, in holes in e earth; others under stones, and among rotten wood: that nothing is more dangerous than removing those bstances in the places where they breed.

The Gally-worm differs from the Scolopendra, in havg double the number of feet; there being two on each de, to every joint of the body. Some of these are smooth, nd others hairy; some are yellow, some black, and some rown. They are found among decayed trees, between he wood and the bark; as also among stones that are cov-red with moss. They all, when touched, contract themelve, rolling themselves up like a ball. Whatever may be their qualities in the tropical parts of the world, in Europe hey are perfectly harmless; having been often handled and irritated, without any vindictive consequences.

All these, as well as the scorpion, are supposed to be produced perfect from the parent, or the egg; and to undergo no changes after their first exclusion. They are seen of all sizes; and this is a sufficient inducement to suppose that they preserve their first appearance through their whole existence. It is probable, however, that, like most of this class, they often change their skins; but of this we have no certain information.

THE LEECH,

From its uses in medicine, is one of those insects that man has taken care to propagate: but, of a great variety, one kind only is considered as serviceable. The Horse Leech, which is the largest of all, and grows to four inches in length, with a glossy black surface, is of no use, as it will not stick to the skin; the Snail Leech is but an inch in length; and though it will stick, is not

large enough to extract a sufficient quantity of blood fro
the patient; the BROAD-TAILED LEECH, which grows to
inch and a half in length, with the back raised into a so
of a ridge, will stick but on very few occasions; it is th
large BROWN LEECH with a whitish belly, that is made u
of in medicine, and whose history best merits our c
riosity.

The Leech has the general figure of a worm, and is abo
as long as one's middle finger. Its skin is composed of rin
by means of which it is possessed of its agility, and swims
water. It contracts itself when out of water, in such a ma
ner that, when touched, it is not above an inch long.
has a small head, and a black skin, edged with a yellow lin
on each side, with some yellowish spots on the back. Th
belly also, which is of a reddish colour, is marked wit
whitish yellow spots. But the most remarkable part of thi
animal is the mouth, which is composed of two lips, that
take whatever form the insect finds convenient. When a
rest, the opening is usually triangular; and within it ar
placed three very sharp teeth, capable of piercing not onl
the human skin, but also that of a horse or an ox. Still
deeper in the head is discovered the tongue, which is composed of a strong fleshy substance, and which serves to assist the animal in sucking, when it has inflicted its triple wound; for no sooner is this voracious creature applied to the skin, than it buries its teeth therein, then closes its lips round the wound which it has made; and thus, in the manner of a cupping-glass, extracts the blood as it flows to the different orifices.

In examining this animal's form farther towards the tail, it is seen to have a gullet, and an intestinal canal, into which the blood flows in great abundance. On each side of this are seen running along several little bladders, which, when the animal is empty, seem to be filled with nothing

of water; but when it is gorging blood, they seem to communicate with the intestines, and receive a large portion of the blood which flows into the body. If these bladders should be considered as so many stomachs, then every Leech will be found to have twenty-four. But what is most extraordinary of all in this animal's formation is, that, though it takes so large a quantity of food, it has no anus or passage to eject it from the body when it has been digested. On the contrary, the blood which the Leech has thus sucked remains for several months clotted within its body, blackened a little by the change, but no way putrefied, and very little altered in its texture or consistence. In what manner it passes through the animal's body, or how it contributes to its nourishment, is not easily accounted for. The water in which they are kept is very little discoloured by their continuance; they cannot be supposed to return the blood by the same passage through which it was taken in; it only remains, therefore, that it goes off through the pores of the body, and that these are sufficiently large to permit its exclusion.

But it is not in this instance alone that the Leech differs from all other insects. It was remarked in a former section, that the whole insect tribe had the opening into their lungs placed in their sides; and that they breathed through those apertures as other animals through the mouth. A drop of oil poured on the sides of a wasp, a bee, or a worm, would quickly suffocate them, by stopping up the passages through which they breathe; but it is otherwise with the Leech, for this animal may be immersed in oil without injury; nay, it will live therein; and the only damage it will sustain is, that when taken out, it will be seen to cast a fine pellucid skin, exactly of the shape of the animal, after which it is as alert and vigorous as before. It appears from this, that the Leech breathes through the mouth; and, in fact, it has a

motion that seems to resemble the act of respiration in more perfect animals; but concerning all this we are very much in the dark.

This Leech is viviparous, and produces its young one after the other, to the number of forty or fifty at a birth. It is probable that, like the snail, each insect contains the two sexes, and that it impregnates, and is impregnated, in the same manner. The young ones are chiefly found, in the month of July, in shallow running waters, and particularly where they are tepified by the rays of the sun. The large ones are chiefly sought after; and, being put into a glass vessel filled with water, they remain for months, nay, for years, without taking any other subsistence. But they never breed in this confinement; and, consequently, what regards that part of their history still remains obscure.

In England they seldom grow to above four inches; but in the East they are found from six to seven. Their pools there abound with them in such numbers, that it would be dangerous bathing there, if from no other consideration. The English sailors and soldiers, who during the last war were obliged to walk in those countries through marshy grounds, talk with terror of the number of Leeches that infested them on their march. Even in some parts of Europe they increase so as to become formidable. Sedelius, a German physician, relates, that a girl of nine years old, who was keeping sheep near the city of Bomst, in Poland, perceiving a soldier making up to her, went to hide herself in a neighbouring marsh, among some bushes; but the number of Leeches was so great in that place, and they stuck to her so close, that the poor creature expired from the quantity of blood which she lost by their united efforts. Nor is this much to be wondered at, since one of these insects, of a large size, will draw about an ounce of blood.

When Leeches are to be applied, the best way is to take

them from the water in which they are contained, about an hour before, for they thus become more voracious, and fasten more readily. When saturated with blood, they generally fall off of themselves; but if it be thought necessary to take them from the wound, care should be used to pull them very gently, or even to sprinkle them with salt, if they continue to adhere; for if they be plucked rudely away, it most frequently happens that they leave their teeth in the wound, which makes a very troublesome inflammation, and is often attended with danger. If they be slow in fixing to the part, they are often enticed by rubbing it with milk, or blood, or water mixed with sugar. As salt is poison to most insects, many people throw it upon the Leech when it has dropped from the wound, which causes it to disgorge the blood it has swallowed, and it is then kept for repeated application. They seldom, however, stick after this operation; and, as the price is but small, fresh Leeches should always be applied whenever such an application is thought necessary.

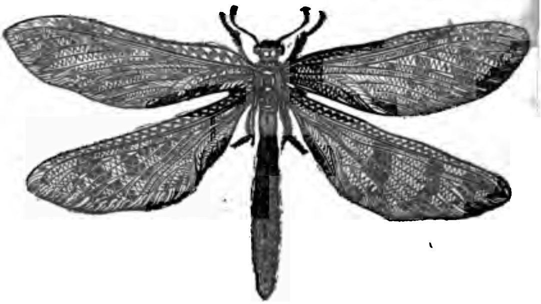
CHAP. XIII.

The Second Order of Insects.....The DRAGON-FLY....*Th* ANT-LION....*The* GRASSHOPPER....*The Locust....The Grea West Indian Locust....The House Cricket....The Woo Cricket....The Mole Cricket....The* EARWIG....*The Frot Worm.....The Water Fly.....The Water Scorpion.....Th* EPHEMERA.

WE come now to a second order of insects, that are produced from the egg, like the former, but not in a perfect state; for, when first excluded, they are without wings.

To this order we may, in the first place, refer the

LIBELLULA, OR DRAGON-FLY.



Of all the flies which adorn or diversify the face of nature, these are the most various and the most beautiful; they are of all colours; green, blue, crimson, scarlet, white, &c.

They are distinguished from all other flies by the length of their bodies, the largeness of their eyes, and the beautiful transparency of their wings, which are four in number.

They are seen in summer flying with great rapidity near every hedge, and by every running brook; they sometimes settle on the leaves of plants, and sometimes keep for hours together on the wing.

Dragon flies, though there are three or four different kinds, yet agree in the most striking parts of their history, and one account may serve for all. The largest sort are generally found from two to three inches long; their tail is forked; their body divided into eleven rings; their eyes are large, horny, and transparent, divided by a number of intersections; and their wings, that always lie flat when they are at rest, are of a beautiful glossy transparency; sometimes shining like silver, and sometimes glistening like gold. Within the mouth are to be seen two teeth, covered with a beautiful lip: with these the creatures bite fiercely when they are taken; but their bite is not venomous.

These insects, beautiful as they are, are produced from eggs, which are deposited in the water, where they remain for some time without seeming life or motion. They are ejected by the female into the water in clusters, like a bunch of grapes, where they sink to the bottom by their natural weight, and continue in that state till the young ones find strength enough to break the shell, and to separate from each other. The form in which they first show life is that of a worm with six legs, bearing a strong resemblance to the Dragon-Fly in its winged state, except that the wings are yet concealed within a sheath peculiar to this animal. The rudiments of these appear in bunches on the back, within which the wings are folded up into each other, while all the colours and varieties of painting appear transparent through the skin. These animals, upon quitting the egg, still continue in the water, where they creep and swim, but do not move swiftly. They

have likewise a sharp sight, and immediately sink to the bottom, if any one comes to the places where they live, or whenever they perceive the least uncommon object. Their food at that time is soft mud and the glutinous earthy substances that are found at the bottom.

In this state, its mode of locomotion is of a truly singular kind. Its abdomen is, in fact, a syringe. When the piston is drawn up, the pressure of the fluid fills the vacuum. The piston is then thrust down, the water is expelled, and the consequent resistance of the element in which it swims moves the Libellula forward in the opposite direction.

When these animals prepare to change from their reptile to their flying state, they then move out of the water to a dry place; as into grass, to pieces of wood, stone, or any thing else they meet with. They there firmly fix their acute claws; and, for a short time, continue quite immoveable, as if meditating on the change they are to undergo. It is then observed, that the skin first opens on the head and back; and out of this opening they exhibit their real head and eyes, and at length their six legs; whilst, in the mean time, the hollow and empty skin, or slough of their legs, remains firmly fixed in its place. After this, the creature creeps forward by degrees; and by this means draws first its wings, and then its body, out of the skin; and, proceeding a little farther, sits at rest for some time, as if immoveable. During this time the wings, which were moist and folded, begin by degrees to expand themselves, and to make smooth and even all those plaits which were laid against each other, like a closed fan. The body is likewise insensibly extended, until all the limbs have obtained their proper size and dimensions.

No animal is more amply fitted for motion, subsistence,

and enjoyment. As it haunts and seeks after its food flying in the air, nature has provided it with two large eyes, which make almost the whole head, and which resemble glittering mother-of-pearl.

As the wings are long, and the legs short, they seldom walk, but are ever seen either resting or flying.

Thus they are seen, adorning the summer with a profusion of beauty, lightly traversing the air in a thousand directions, and expanding the most beautiful colours to the sun. The garden, the forest, the hedges, and the rivulets, are animated by their sports; and there are few who have been brought up in the country, who have not employed part of their childhood in the pursuit.

But while these beautiful flies appear to us so idly and innocently employed, they are in fact the greatest tyrants of the insect tribe; and, like the hawk among birds, are only hovering up and down to seize their prey. They are the strongest and the most courageous of all winged insects; nor is there one, how large soever, that they will not attack and devour. The blue fly, the bee, the wasp, and the hornet make their constant prey; and even the butterfly, that spreads so large a wing, is often caught and treated without mercy. Their appetite seems to know no bounds; they spend the whole day in the pursuit, and have been seen to devour three times their own size in the capture of a single hour. They seize their prey flying, with their six claws, and tear it easily to pieces with their teeth, which are capable of inflicting troublesome wounds.

THE ANT-LION.

Although this animal properly belongs to no order of insects, yet, as it is changed into a fly very much resembling

that previously described, it may not be improper to give its history here.

The Ant-Lion, in its reptile state, is of the size of a common wood-louse, but somewhat broader. It has a pretty long head, and roundish body, which becomes a little narrower towards the tail. The colour is a dirty gray, speckled with black, and the body is composed of several flat rings, which slip one upon another. It has six feet, four of which are fixed to the breast, and two to the neck. The head is small and flat; and before there are two little smooth horns and feelers, which are hard, about a quarter of an inch long, and crooked at the ends. At the basis of the feelers there are two small black lively eyes, by which it can see the smallest object, as is easily discovered by its starting from every thing that approaches.

To a form so unpromising, and so ill provided for the purposes of rapacity, this animal unites the most ravenous appetites in nature; but to mark its imbecility still stronger, as other animals have wings or feet to enable them to advance towards their prey, the Ant-Lion is unprovided with such assistance from either. It has legs indeed, but these only enable it to run backward, so that it could as soon die as make the smallest progressive motion. Thus, famished and rapacious as it ever seems, its prey must come to it, or rather into the snare provided for it, or the insidious assassin must starve.

But Nature, that has denied it strength or swiftness, has given it an equivalent in cunning; so that no animal fares more sumptuously, without ever stirring from its retreat. For this purpose, it chooses a dry sandy place, at the foot of a wall, or under some shelter, in order to preserve its machinations from the rain. The driest and most sandy spot is the most proper for it; because a heavy clogged earth would defeat its labour. When it goes about to dig

the hole where it takes its prey, it begins to bend the hinder part of its body, which is pointed, and thus works backward: making, after several attempts, a circular furrow which serves to mark out the size of the hole it intends making, as the ancients marked out the limits of a city with a plough. Within this first furrow it digs a second, then a third, and afterwards others, which are always less than the preceding. Then it begins to deepen its hole, sinking lower and lower into the sand, which it throws with its horns, or feelers, towards the edges, as we see men throw up sand in a gravel pit. Thus, by repeating its labours all around, the sand is thrown up in a circle about the edge of the pit, until the hole is quite completed. This hole is always formed in a perfect circle; and the pit itself resembles the inside of an inverted funnel. If, in the course of its work, it is impeded by any small stones, it places them, one by one, on its head, and jerks them out beyond the excavation.

The work being thus with great labour finished, the insidious insect places itself in ambush, hiding itself in the bottom under the sand in such a manner that its two horns encircle the bottom of the pit. All the sides of this pitfall are made of the most loose and crumbling materials; so that scarcely any insect can climb up that has once got down to the bottom. Conscious of this, the Ant-Lion remains in patient expectation, ready to profit by that accident which throws some heedless little animal into his den. If then, by misfortune, an ant, a wood-louse, or a small caterpillar, walks too near the edge of the precipice, the sand gives way beneath them, and they fall to the bottom of the pit, where they meet inevitable destruction. The fall of a single grain of sand gives the creature notice at the bottom of its cave; and it never fails to sally forth to seize upon its prey. It happens sometimes, however, that the

ant or the wood-louse is too nimble, and runs up the side of the pitfall before the other can make ready to seize it. The Ant-Lion has then another contrivance, still more wonderful than the former; for, by means of its broad head and feelers, it has a method of throwing up a shower of sand which falls upon the struggling captive with tremendous weight, and once more crushes it down to the bottom.

When the prey is reduced to a husk, and nothing but the external form remains, the next care of the Ant-Lion is to remove the body from its cell; therefore, taking up the wasted trunk with its feelers, it throws it, with wonderful strength, at least six inches from the edge of its hole; and then patiently sets about mending the breaches which its fortifications had received in the last engagement.

When the Ant-Lion attains a certain age, in which it is to change into another form, it then leaves off its usual rapacious habits.

These animals are produced in autumn, and generally live a year, and perhaps two, before they assume a winged form.

When the time of change approaches, if the insect finds its little cell convenient, it seeks no other: if it is obliged to remove, after furrowing up the sand, it hides itself under it, horns and all. It there spins a thread, in the manner of the spider; which being made of a glutinous substance, and being humid from the moisture of its body, sticks to the little particles of sand among which it is spun; and in proportion as it is thus excluded, the insect rolls up its web, sand and all, into a ball, of which itself is the centre. This ball is about half an inch in diameter; and within it the insect resides, in an apartment sufficiently spacious for all its movements. The outside is composed of sand and silk; the inside is lined with silk only, of a fine pearl

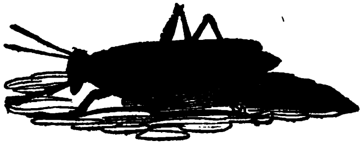
colour, extremely delicate, and perfectly beautiful. But, though the work is so curious within, it exhibits nothing, to external appearance, but a lump of sand; and thus escapes the search of birds, that might otherwise disturb the inhabitant within.

The insect continues thus shut up for six weeks or two months; and gradually parts with its eyes, its feelers, its feet, and its skin; all which are thrust into a corner of the inner apartment, like a rag. The insect then appears almost in its winged state, except that there is a thin skin which wraps up the wings, and which appears to be nothing else but a liquor dried on their outside. Still, however, the little animal is too delicate and tender to venture from its retreat; but continues enclosed for some time longer: at length, when the members of this new insect have acquired the necessary consistence and vigour, it tears open its lodging, and breaks through its wall. For this purpose, it has two teeth like those of grasshoppers, with which it eats through, and enlarges the opening, till it gets out. Its body, which is turned like a screw, takes up no more than the space of a quarter of an inch; but when it is unfolded, it becomes half an inch in length; while its wings, that seemed to occupy the smallest space, in two minutes' time unfold, and become longer than the body. In short, it becomes a large and beautiful fly, of the libellula kind, with a long, slender body, of a brown colour; a small head, with large bright eyes, long slender legs, and four large, transparent, reticulated wings. The rest of its habits resemble that insect whose form it bears; except that, instead of dropping its eggs in the water, it deposits them in sand, where they are soon hatched into that rapacious insect, so justly admired for its method of catching its prey.

THE GRASSHOPPER, THE LOCUST, THE CRICKET, &c.

THAT animal which is called the Grasshopper, with us differs greatly from the cicada of antiquity; for, as our insect is active enough in hopping through the long grass, whence it has taken its name, the cicada had not this power, but either walked or flew. The little hissing note also of our Grasshopper is very different from the song of the cicada, which was louder, andfar more musical.

Of this variegated tribe, the LITTLE GRASSHOPPER, that



breeds in such plenty in every meadow, and that continues his chirping through the summer, is best known to us; and, by having its history, we shall be possessed of that of all the rest. This animal is of the colour of green leaves, except a line of brown which streaks the back, and two pale lines under the belly, and behind the legs. It may be divided into the head, the corslet, and the belly. The head is oblong, regarding the earth, and bearing some resemblance to that of a horse. Its mouth is covered by a kind of round buckler jutting over it, and armed with teeth of a brown colour, hooked at the points. Within the mouth is perceivable a large reddish tongue, fixed to the lower jaw. The feelers, or horns, are very long, tapering on to a point, and the eyes are like two black specks, a little prominent. The corslet is elevated, nar-

row, armed above and below by two serrated spines. The back is armed with a strong buckler, to which the muscles of the legs are firmly bound; and round these muscles are seen the vessels by which the animal breathes, as white as snow. The last pair of legs are much longer and stronger than the first two pair, fortified by thick muscles, and very well formed for leaping. It has four wings; the anterior ones springing from the second pair of legs, the posterior from the third pair. The hinder wings are much finer and more expansive than the foremost, and are the principal instruments of its flight. The belly is considerably large, composed of eight rings, and terminated by a forky tail, covered with down, like the tail of a rat. When examined internally, besides the gullet, we discover a small stomach; and behind that a very large one, wrinkled and furrowed withinside; lower down there is still a third; so that it is not without reason that all the animals of this order are said to chew the cud, as they so much resemble ruminating animals in their internal conformation.

A short time after the Grasshopper assumes its wings, it fills the meadow with its note; which, like that among birds, is a call to courtship. The male only of this tribe is vocal; and upon examining it at the base of the wings, there will be found a little hole in its body, covered with a fine transparent membrane. This is thought, by Linnæus, to be the instrument it employs in singing; but others are of opinion, the sound is produced by rubbing its hinder legs against each other: however this may be, the note of one male is seldom heard, but it is returned by another; and the two little animals, after many mutual insults of this kind, are seen to meet and fight desperately. The female is generally the reward of victory; for, after the combat, the male seizes her with his teeth behind the neck, and thus keeps her for several hours.

Towards the latter end of autumn, the female prepares to deposit her burthen; and her body is then seen greatly distended with her eggs, which she carries to the number of a hundred and fifty. In order to make a proper lodgment in the earth for them, nature has furnished her with an instrument at her tail, somewhat resembling a two-edged sword, which she can sheathe and unsheathe at pleasure; with this she pierces the earth as deep as she is able; and into the hole which her instrument has made, she deposits her eggs, one after the other.

Having thus provided for the continuation of her posterity, the animal herself does not long survive; but, as the winter approaches, she dries up, seems to feel the effects of age, and dies from a total decay. Some, however, assert, that she is killed by the cold; and others, that she is eaten by worms; but certain it is, that neither the male nor female are ever seen to survive the winter. In the mean time, the eggs which have been deposited continue unaltered, either by the severity of the season, or the retardation of the spring. They are of an oval figure, white, and of the consistence of horn: their size nearly equals that of a grain of anise: they are enveloped in the body within a covering, branched all over with veins and arteries; and when excluded, they crack, on being pressed between the fingers: their substance within is a whitish, viscous, and transparent fluid.

Generally, about the beginning of May, every egg produces an insect, about the size of a flea; these at first are of a whitish colour; at the end of two or three days they turn black; and soon after they become of a reddish brown. They appear, from the beginning, like Grasshoppers wanting wings; and hop among the grass, as soon as excluded, with great agility.

Yet still they are by no means arrived at their state of

full perfection; although they bear a strong resemblance to the animal in its perfect form. They want, or seem to want, the wings, which they are at last seen to assume; and can only hop among the grass, without being able to fly. The wings, however, are not wanting, but are concealed within four little bunches, that seem to deform the sides of the animal: there they lie rolled up in a most curious manner, and occupying a smaller space than one could conceive. Indeed, all insects, whatever transmutations they seem to undergo, are yet brought forth with those very limbs, parts, and wings, which they afterwards seem to acquire. In the most helpless caterpillar, there are still to be seen the rudiments of that beautiful plumage which it afterwards expands when a butterfly: and though many new parts seem unfolded to the view, the animal acquires none but such as it was from the beginning possessed of.

The Grasshopper, that for above twenty days from its exclusion has continued without the use of its wings, which were folded up to its body, at length prepares for its emancipation, and for a life of greater liberty and pleasure. To make the proper dispositions for the approaching change, it ceases from its grassy food, and seeks about for a convenient place, beneath some thorn or thistle, that may protect it from an accidental shower. The same laborious writhings and workings, heavings and palpitations, which we have remarked in every other insect upon an approaching change, are exhibited in this.

At length, the skin covering the head and breast is seen dividing above the neck; the head is seen issuing out first from the bursting skin; the efforts still continuing, the other parts follow successively; so that the little animal, with its long feelers, legs and all, works its way from the old skin, that remains fixed to the thistle or the

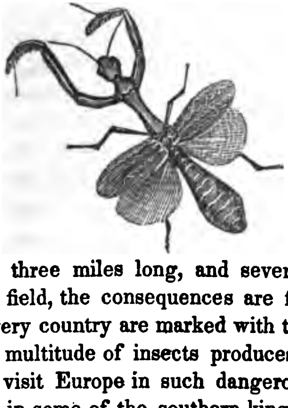
thorn. It is, indeed, inconceiveable how the insect thus extricates itself from so exact a sheath as that which covered every part of its body.

The Grasshopper, thus disengaged from its outer skin, appears in its perfect form; but then so feeble, and its body so soft and tender, that it may be moulded like wax. It is no longer of that obscure colour which it exhibited before, but a greenish white, which becomes more vivid as the moisture on the surface is dried away. Still, however, the animal continues to show no signs of life, but appears quite spent and fatigued with its labour for more than an hour together. During this time, the body is drying, and the wings unfolding to their greatest expansion; and the curious observer will perceive them, fold after fold, opening to the sun, till at last they become longer than the two hinder legs. The insect's body also is lengthened during this operation, and it becomes much more beautiful than before.

These insects are generally vocal in the midst of summer; and they are heard at sun-setting much louder than during the heat of the day. They feed upon grass; and, if their belly be pressed, they will be seen to return the juices of the plants they have last fed upon. Though unwilling to fly, and slow in flight, particularly when the weather is moist or cool, they are sometimes seen to fly to considerable distances. If they are caught by one of the hinder legs, they quickly disengage themselves from it, and leave the leg behind them. This, however, does not grow again, as with crabs or spiders; for as they are animals but of a single year's continuance, they have not sufficient time for repairing these accidental misfortunes. The loss of their leg also prevents them from flying; for, being unable to lift themselves in the air, they have not room upon the ground for the proper expansion of their

wings. If they be handled roughly, they will bite very fiercely; and when they fly, they make a noise with their wings. They generally keep in the plain, where the grass is luxuriant, and the ground rich and fertile: there they deposit their eggs, particularly in those cracks which are formed by the heat of the sun.

Such are the habits and nature of these little vocal insects, that swarm in our meadows, and enliven the landscape. The larger kinds only differ from them in size, in rapidity of flight, and the powers of injuring mankind, by swarming upon the productions of the earth. The quantity of grass which a few Grasshoppers that sport in the fields can destroy is trifling; but when a swarm of Lo-



custs two or three miles long, and several yards deep, settle upon a field, the consequences are frightful. The annals of every country are marked with the devastation which such a multitude of insects produces; and though they seldom visit Europe in such dangerous swarms as formerly, yet, in some of the southern kingdoms, they are still formidable. Those which have, at uncertain intervals, visited Europe, in our memory, are supposed to have come from Africa, and the animal is called the Great Brown Locust. It was seen in several parts of England, in the year 1748, and many dreadful consequences were apprehended from its appearance. This insect is about three

inches long; and has two horns, or feelers, an inch in length. The head and horns are of a brownish colour; it is blue about the mouth, as also on the inside of the larger legs. The shield that covers the back is greenish; and the upper side of the body brown, spotted with black, and the under side purple. The upper wings are brown, with small dusky spots, with one larger at the tips; the under wings are more transparent, and of a light brown, tinctured with green, but there is a dark cloud of spots near the tips.

There is no animal in the creation that multiplies so fast as these, if the sun be warm, and the soil in which their eggs are deposited be dry.

The Scripture, which was written in a country where the Locust made a distinguished feature in the picture of nature, has given us several very striking images of this animal's numbers and rapacity. It compares an army, where the numbers are almost infinite, to a swarm of Locusts: it describes them as rising out of the earth, where they are produced; as pursuing a settled march to destroy the fruits of the earth, and cooperate with divine indignation.

When the Locusts take the field, as we are assured, they have a leader at their head, whose flight they observe, and pay a strict attention to all his motions. They appear at a distance, like a black cloud, which, as it approaches, gathers upon the horizon, and almost hides the light of the day. It often happens, that the husbandman sees this imminent calamity pass away without doing him any mischief; and the whole swarm proceed onward to settle upon the labours of some less fortunate country. But wretched is the district upon which they settle: they ravage the meadow and the pasture ground; strip the trees of their leaves, and the garden of its beauty; the visitation of a few

minutes destroys the expectations of a year; and a famine but too frequently ensues. In their native tropical climates, they are not so dreadful as in the southern parts of Europe. There, though the plain and the forest be stripped of their verdure, the power of vegetation is so great, that an interval of three or four days repairs the calamity: but in the North of Europe, the verdure is the livery of a season; and when lost, the inhabitants must wait till the ensuing spring repairs the damage. Besides, in their long flights to this part of the world, they are famished by the tediousness or their journey, and are therefore more voracious wherever they happen to settle. But it is not by what they devour that they do so much damage as by what they destroy. Their very bite is thought to contaminate the plant, and to prevent its vegetation. To use the expression of the husbandman, they burn whatever they touch; and leave the marks of their devastation for two or three years ensuing. But if they be noxious while living, they are still more so when dead; for wherever they fall, they infect the air in such a manner, that the smell is insupportable.

Orosius tells us, that in the year of the world 3800, there was an incredible number of Locusts which infested Africa; and, after having eaten up every thing that was green, they flew off, and were drowned in the African sea; where they caused such a stench, that the putrefying bodies of hundreds of thousands of men could not equal it.

In the year 1650, a cloud of Locusts was seen to enter Russia in three different places; and thence to spread themselves over Poland and Lithuania, in such astonishing multitudes, that the air was darkened, and the earth covered with their numbers. In some places they were seen lying dead, heaped upon each other four feet deep; in others, they covered the surface like a black cloth: the trees bent beneath their weight; and the damage which

the country sustained exceeded computation. In Barbary their numbers are formidable, and their visits are frequent. In the year 1724, Dr. Shaw was a witness in that country of their devastations. Their first appearance was about the latter end of March, when the wind had been southerly for some time. In the beginning of April, their numbers were so vastly increased, that, in the heat of the day, they formed themselves into large swarms, which appeared like clouds, and darkened the sun. In the middle of May, they began to disappear, retiring into the plains to deposit their eggs. In the next month, being June, the young brood began to make their appearance, forming many compact bodies of several hundred yards square; which afterwards marching forward, climbed the trees, walls, and houses, eating every thing that was green in their way. The inhabitants, to stop their progress, formed trenches all over their fields and gardens, filling them with water. Some placed large quantities of heath, stubble, and such like combustible matter, in rows, and set them on fire, on the approach of the Locusts; but all this was to no purpose; for the trenches were quickly filled up, and the fires put out by the vast number of swarms that succeeded each other. A day or two after one of these was in motion, others that were just hatched came to glean after them, gnawing off the young branches, and the very bark of the trees. Having lived near a month in this manner, they arrived at their full growth, and threw off their wormlike state, by casting their skins. To prepare themselves for this change, they fixed their hinder feet to some bush or twig, or corner of a stone, when immediately, by an undulating motion used on this occasion, their heads would first appear, and soon after the rest of their bodies. The whole transformation was performed in seven or eight minutes' time; after which, they were a little while in a languishing

condition; but as soon as the sun and air had hardened their wings, and dried up the moisture that remained after casting off their sloughs, they returned again to their former greediness, with an addition both of strength and agility. But they did not continue long in this state before they were entirely dispersed; after laying their eggs, directing their course northward, and probably perished in the sea. It is said, that the holes these animals make, to deposit their eggs, are four feet deep in the ground; the eggs are about fourscore in number, of the size of carraway comfits, and bundled up together in clusters.

In some parts of the world, the inhabitants turn what seems a plague to their own advantage. Locusts are eaten by the natives in many kingdoms of the East; and are caught in small nets provided for that purpose. They parch them over the fire in an earthen pan; and when their wings and legs are fallen off, they turn reddish, of the colour of boiled shrimps. Dampier has eaten them thus prepared, and thinks them a tolerable dish. The natives of Barbary also eat them fried with salt; and they are said to taste like crayfish.

There is a Locust in Tonquin, about the thickness of the top of a man's finger, and as long as the first joint. It breeds in the earth, in low grounds; and in the months of January and February, which is the season for taking them, they issue from the earth in vast swarms. At first these can hardly fly, so that they often fall into the rivers in great numbers: however, the natives in these months watch the rivers, and take them up in multitudes in small nets. They either eat them fresh, broiled on the coals, or pickle them for keeping. They are considered as a great delicacy in that part of the world, as well by the rich as the poor. In the countries where they are eaten, they are regularly brought to market, and sold as larks or quails

in Europe. They must have been a common food with the Jews, as Moses, in the book of Leviticus, permits them to eat four different kinds of this animal, which he takes care to specify. This dish, however, has not yet made its way into the kitchens of the luxurious in Europe; and though we may admire the delicacies of the East, we are as yet happily deprived of the power of imitation.

The CRESTED LOCUST, which inhabits the East, is a highly beautiful animal, being of a bright red, with the body annulated with black, and the legs varied with yellow; the upper wings are marked with variegations of dark and pale green; the lower with transverse undulated streaks. The length of this species, from head to tail, is about four inches; and the expanse of wings from tip to tip, when fully extended, hardly less than seven inches and a half.

Of all animals, however, of this noxious tribe, the GREAT WEST INDIAN LOCUST, individually considered, is the most formidable. It is about the thickness of a goose quill, and the body is divided into nine or ten joints, in the whole about six or seven inches long. It has two small eyes, standing out of the head like those of crabs, and two feelers like long hair. The whole body is studded with small excrescences, which are not much bigger than the points of pins. The shape is roundish, and the body diminishes in circumference to the tail, which is forked into two horns. Between these, there is a sort of sheath, containing a small dangerous sting. If any person happens to touch this insect, he is sure to be stung, and is immediately taken with a shivering and trembling all over the body; which, however, may soon be put a stop to, by rubbing the place that was affected with a little palm oil.

From the Locust we descend to the Cricket, which is a very inoffensive animal. Though there is a species of this insect that lives entirely in the woods and fields, yet

that with which we are best acquainted is the House Cricket, whose voice is so well known behind a country fire in a winter's evening. There is something so unusual in hearing a sound while we do not see the animal producing it, nor discover the place whence it comes, that among the country people the chirping of the cricket is always held ominous; and whether it deserts the fireside, or pays an unexpected visit, the credulous peasantry always find something to be afraid of.

The Cricket very much resembles the grasshopper in its shape, its manner of ruminating, its voice, its leaping, and methods of propagation. It differs in its colour, which is uniformly of a rusty brown; in its food, which is more various; and in its place of residence, which is most usually in the warmest chinks behind a country hearth. They are, in some measure, obliged to the bad masonry employed in making peasants' houses for their retreats. The smallest chink serves to give them shelter, and where they once make their abode they are sure to propagate. They are of a most chilly nature, seldom leaving the fireside; and if undisturbed, are seen to hop from their retreats to chirp at the blaze in the chimney. The Wood Cricket is the most timorous animal in nature; but the Chimney Cricket, being used to noises, disregards them. Whether the voice of this animal is formed in the same manner with that of the grasshopper, is not yet ascertained; nor do we well know the use of this voice, since anatomical inspection has not been able to discover the smallest organs of hearing. Still, however, we can make no doubt of their power of distinguishing sounds, though probably not in the same

manner with the more perfect ranks of nature. Certain it is, that they have been often heard to call, and this call is as regularly answered by another, although none but the males are vocal.

They are very voracious little animals, and will eat bread, flour, meat, and scummings of pots; but are particularly fond of sugar. They are a thirsty race, and show a great predilection for liquids, being often found drowned in pans of water, milk, or broth. Whatever is moist they affect; and therefore frequently gnaw holes in wet woollen stockings and aprons that are hung to the fire.

The great Scaliger was particularly delighted with the chirping of Crickets, and kept several of them for his amusement, enclosed in a box, which he placed in a warm situation. Others, on the contrary, think there is something ominous and melancholy in the sound, and use every endeavour to banish this insect from their houses.

Ledelius tells us of a woman who was very much incommoded by Crickets, and tried, but in vain, every method of banishing them from her house. She at last accidentally succeeded; for having one day invited several guests to her house, where there was a wedding, in order to increase the festivity of the entertainment, she procured drums and trumpets to entertain them. The noise of these was so much greater than what the little animals were used to, that they instantly forsook their situation, and were never heard in that mansion more.

THE FIELD CRICKET.

Of this insect an amusing account is given by the author of the Natural History of Selborne. "There is (says he) a steep abrupt pasture field, interspersed with furze, close to the back of this village, well known by the name of the Short Lithe, consisting of a rocky dry soil, and inclining

to the afternoon sun. This spot abounds with the *Gryllus Campestris*, or Field Cricket; which, though frequent in these parts, is by no means a common insect in many other countries.

"As their cheerful summer cry cannot but draw the attention of a naturalist, I have often gone down to examine the economy of these *Grylli*, and study their mode of life, but they are so shy and cautious that it is no easy matter to get a sight of them; for, feeling a person's footsteps as he advances, they stop short in the midst of their song, and retire backward nimbly into their burrows, where they lurk till all suspicion of danger is over.

"At first we attempted to dig them out with a spade, but without any great success; for either we could not get to the bottom of the hole, which often terminated under a great stone; or else, in breaking up the ground, we inadvertently squeezed the poor insect to death. Out of one so bruised we took a multitude of eggs, which were long and narrow, of a yellow colour, and covered with a very tough skin. By this accident we learned to distinguish the male from the female; the former of which is shining black, with a golden stripe across his shoulders; the latter is more dusky, more capacious about the abdomen, and carries a long sword-shaped weapon at her tail, which probably is the instrument with which she deposits her eggs in crannies and safe receptacles.

"Where violent methods will not avail, more gentle means will often succeed; and so it proved in the present case; for though a spade be too boisterous and rough an implement, a plant stalk of grass, gently insinuated into the caverns, will probe their windings to the bottom, and quickly bring out the inhabitant; and thus the humane inquirer may gratify his curiosity without injuring the object of it. It is remarkable that, though these insects are furnished

with long legs behind, and brawny thighs for leaping, like grasshoppers; yet when driven from their holes they show no activity, but crawl along in a shiftless manner, so as easily to be taken: and again, though provided with a curious apparatus of wings, yet they never exert them where there seems to be the greatest occasion. The males only make that shrilling noise, perhaps out of rivalry and emulation, as is the case with many animals which exert some sprightly note during their breeding time: it is raised by a brisk friction of one wing against the other. They are solitary beings, living singly male or female, each as it may happen; but there must be a time when the sexes have some intercourse, and then the wings may be useful perhaps during the hours of night. When the males meet, they will fight fiercely, as I found by some which I put into the crevices of a dry stone wall, where I should have been glad to have made them settle. For though they seemed distressed by being taken out of their knowledge, yet the first that got possession of the chinks would seize on any that were obtruded upon them, with a vast row of serrated fangs. With their strong jaws, toothed like the shears of a lobster's claws, they perforate and round their curious regular cells, having no fore claws to dig, like the Mole Cricket. When taken in the hand, I could not but wonder that they never offered to defend themselves, though armed with such formidable weapons. Of such herbs as grow before the mouths of their burrows they eat indiscriminately; and on a little platform, which they make just by, they drop their dung; and never in the daytime seem to stir more than two or three inches from home. Sitting in the entrance of their caverns, they chirp all night as well as day, from the middle of the month of May to the middle of July, and in hot weather, when they are most vigorous, they make the hills echo; and, in the still hours of darkness,

may be heard to a considerable distance. In the beginning of the season their notes are more faint and inward; but become louder as the summer advances, and so die away again by degrees.

"Sounds do not always give us pleasure according to their sweetness and melody; nor do harsh sounds always displease. We are more apt to be captivated or disgusted with the associations which they promote, than with the notes themselves. Thus the shrilling of the Field Cricket, though sharp and stridulous, yet marvellously delights some hearers, filling their minds with a train of summer ideas of every thing that is rural, verdurous, and joyous.

"About the tenth of March, the Crickets appear at the mouths of their cells, which they then open and bore, and shape very elegantly. All that I have ever seen at that season were in that pupa state, and had only the rudiments of wings lying under a skin or coat, which must be cast before the insect can arrive at its perfect state;* from whence I should suppose that the old ones of last year do not always survive the winter. In August their holes begin to be obliterated, and the insects are seen no more till spring.

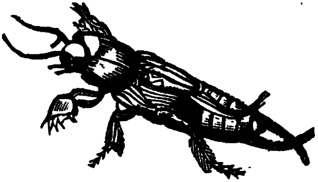
"Not many summers ago I endeavoured to transplant a colony to the terrace in my garden, by boring deep holes in the sloping turf. The new inhabitants staid some time and fed and sung; but wandered away by degrees, and were heard at a further distance every morning; so that it appears that on this emergency they made use of their wings in attempting to return to the spot from which they were taken.

"One of these Crickets, when confined in a paper cage,

* We have observed that they cast their skins in April, which are then seen lying at the mouths of their holes.

and set in the sun, and supplied with plants moistened with water, will feed and thrive, and become so loud and merry as to be irksome in the same room where a person is sitting: if the plants are not wetted, it will die."

But of all the Cricket kind, that which is called the MOLE CRICKET is the most extraordinary. This animal is



the largest of all the insects with which we are acquainted in this country, being two inches and a half in length, and three quarters of an inch in breadth. The colour is of a dusky brown; and, at the extremity of the tail, there are two hairy excrescences, resembling, in some degree, the tail of a mouse. The body consists of eight scaly joints, or separate folds, is brown on the upper part, and more deeply tinged below. The wings are long, narrow, and terminate in a sharp point, each having a blackish line running down it: however, when they are extended, they appear to be much broader than could at first sight be supposed. The shield of the breast is of a firm texture, of a blackish colour, and hairy. The fore feet, which are this animal's principal instruments of burrowing into the earth, are strong, webbed, and hairy; it generally, however, runs backward; but it is commonly under ground, where it burrows even faster than a mole. It is thought also to be amphibious; and capable of living under water, as well as under ground.

Of all insects, this is the most detested by gardeners, as it chiefly resides in that ground which lies light, and where

it finds sufficient plenty under the surface. Thus, in a single night's time, it will run along a furrow which has been newly sown, and rob it of all its contents. Its legs are formed in such a manner, that it can penetrate the earth in every direction, before, behind, and above it. At night it ventures from its underground habitation, and, like the Cricket, has its chirping call.

Nothing can exceed the care and assiduity which these animals exhibit in the preservation of their young. Wherever the nest is placed, there seems to be a fortification, avenues, and entrenchments, drawn round it: there are numberless winding ways that lead to it, and a ditch drawn about it, which few of its insect enemies are able to pass. A species of black-beetle often attacks the young; but the female places herself near the entrance of the nest, seizes behind on the assailing beetle, and bites it asunder. But their care is not confined to this only; for, at the approach of winter, they carry their nest entirely away, and sink it deeper in the ground, so that the frost can have no influence in retarding the young brood from coming to maturity. As the weather grows milder, they raise their magazine in proportion; till, at last, they bring it as near the surface as they can, to receive the genial influence of the sun, without wholly exposing it to view; yet should the frost unexpectedly return, they sink it again as before.

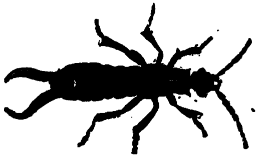
THE GREAT LANTERN FLY.

This is undoubtedly one of the most curious of insects: it is of a very considerable size, measuring nearly three inches and, a half from the tip of the front to that of the tail, and about five inches and a half from wing's end to wing's end, when expanded: the body is of a lengthened oval shape, roundish or subcylindric, and divided into several rings or segments: the length is nearly equal to the

length of the rest of the animal, and is oval, inflated, and bent slightly upwards: the ground colour is an elegant yellow, with a strong tinge of green in some parts, and marked with numerous bright red brown variegations in the form of stripes and spots: the wings are very large, of a yellow colour, most elegantly varied with brown undulations and spots, and the lower pair are decorated by a very large eye-shaped spot on the middle of each, the iris or border of the spot being red, and the centre half red and half semitransparent white: the head or lantern is pale yellow, with longitudinal red stripes. This beautiful insect is a

native of Surinam and many other parts of South America, and during the night diffuses so strong a phosphoric splendour from its head or lantern, that it may be employed for the purpose of a candle or torch; and it is said that three or four of these insects tied to the top of a stick, are frequently used by travellers for that purpose. A single *one* gives light enough to enable a person to read.

THE EARWIG.



We should still keep in memory, that all insects of the second order, though not produced quite perfect from the egg, yet want very little of their perfection, and require but a very small change to arrive at that state which fits them for flight and generation.

Of all this class of insects, the Earwig undergoes the smallest change. This animal is so common, that it scarce needs a description: its swiftness, in the reptile state, is not less remarkable than its indefatigable velocity when upon the wing. That it must be very prolific, appears from its numbers; and that it is very harmless, every one's experience can readily testify. It is provided with six feet, and two feelers: the tail is forked; and with this it often attempts to defend itself against every assailant. But its attempts are only the threats of impotence; they draw down the resentment of powerful animals, but no way serve to defend it. The deformity of its figure, and its slender make, have also subjected it to an imputation, which, though entirely founded in prejudice, has more than once procured its destruction. It is supposed, as the name imports, that it often enters into the ears of people sleeping; thus causing madness, from the intolerable pain, and soon after death itself.

Indeed, the French name, which signifies the ear-piercer, urges the calumny against this harmless insect, in very

plain terms: yet nothing can be more unjust; the ear is already filled with a substance which prevents any insect from entering; and, besides, it is well lined and defended with membranes, which would keep out any little animal, even though the ear-wax were away. These reproaches, therefore, are entirely groundless: but it were well if the accusations which gardeners bring against the Earwig were as slightly founded. There is nothing more certain, than that it lives among flowers, and destroys them. When fruit also has been wounded by flies, the Earwig generally comes in for a second feast, and sucks those juices which they first began to broach. Still, however, this insect is not so noxious as it would seem; and seldom is found but where the mischief has been originally begun by others. Like all of this class, the Earwig is hatched from an egg. As there are various kinds of this animal, so they choose different places to breed in: in general, however, they lay their eggs under the bark of plants, or in the clefts of trees, when beginning to decay. They proceed from the egg in that reptile state in which they are most commonly seen; and, as they grow larger, the wings bound under the skin begin to burgeon. It is amazing how very little room four large wings take up before they are protruded; for no person could ever conceive such an expansion of natural drapery could be rolled up in so small a packet. The sheath in which they are enveloped, folds and covers them so neatly, that the animal seems quite destitute of wings; and even when they are burst from their confinement, the animal, by the power of the muscles and joints which it has in the middle of its wings, can closely fold them into a very narrow compass. When the Earwig has become a winged insect, it flies in pursuit of the female, ceasing to feed, and is wholly employed in the business of propagation. It lives, in its winged state, but

a few days; and, having taken care for the continuance of posterity, dries up, and dies, to all appearance consumptive.

To this order of insects we may also refer the CUCKOW SPIT, or FROTH WORM, that is often found hid in that frothy matter which we find on the surface of plants. It has an oblong, obtuse body; and a large head, with small eyes. The external wings, for it has four, are of a dusky brown colour, marked with two white spots: the head is black. The spume in which it is found wallowing is all of its own formation, and very much resembles frothy spittle. It proceeds from the vent of the animal, and other parts of the body; and if it be wiped away, a new quantity will be quickly seen ejected from the little animal's body. Within this spume, it is seen in time to acquire four tubercles on its back, wherein the wings are enclosed: these bursting, from a reptile it becomes a winged animal; and thus rendered perfect, it flies to meet its mate, and propagate its kind.

THE WATER TIPULA

ALSO belongs to this class. It has an oblong, slender body, with four feet fixed upon the breast, and four feelers near the mouth. It has four weak wings, which do not at all seem proper for flying, but leaping only.

But what this insect chiefly demands our attention for is the wonderful lightness wherewith it runs on the surface of the water, so as scarcely to put it in motion. It is sometimes seen in rivers, and on their banks, especially under shady trees; and generally in swarms of several together.

THE COMMON BOAT-FLY

ALSO breeds in the same manner with those above-mentioned. This animal is by some called the Notonecta, be-

cause it does not swim in the usual manner, upon its belly, but on its back: nor can we help admiring that fitness in this insect for its situation, as it feeds on the under side of plants which grow on the surface of the water; and therefore it is thus formed, with its mouth upwards, to take its food with greater convenience and ease.

We may also add the WATER SCORPION, which is a larger insect, being near an inch in length, and about half an inch in breadth. Its body is nearly oval, but very flat and thin; and its tail long and pointed. The head is small; and the feelers appear like legs, resembling the claws of a scorpion, but without sharp points. This insect is generally found in ponds, and is extremely tyrannical and rapacious.

It destroys, like a wolf among sheep, twenty times as many as its hunger requires. One of these, when put into a bason of water, in which were thirty or forty worms of the libellula kind, each as large as itself, destroyed them all in a few minutes, getting on their backs, and piercing with its trunk through their body. These animals, however, though so formidable to others, are nevertheless themselves greatly overrun with a little kind of louse, about the size of a nit, which very probably repays the injury which the Water Scorpion inflicts upon others.

The Water Scorpions live in the water by day; out of which they rise in the dusk of the evening into the air, and so flying from place to place often betake themselves, in quest of food, to other waters. The insect, before its wings are grown, remains in the place where it was produced; but when come to its state of perfection, sallies forth in search of a companion of the other sex, in order to continue its noxious posterity.

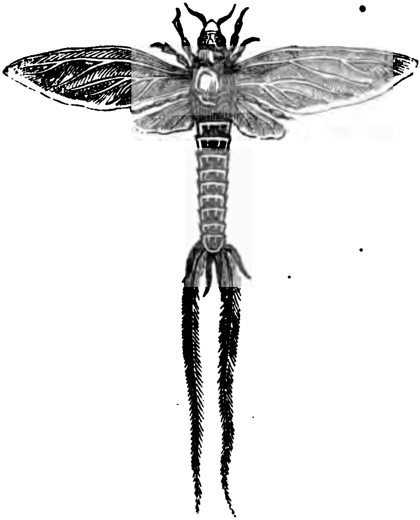
The last insect we shall add to this second order is this EPHEMERA; which, though not strictly belonging to it, yet seems more properly referred to this rank than any other. Indeed, we must not attend to the rigour of method, in a history where Nature seems to take delight to sport in variety.

That there should be a tribe of flies, whose duration extends but to a day, seems at first surprising; but the wonder will increase when we are told, that some of this kind seem to be born and die in the space of a single hour. The reptile, however, from which they are bred, is by no means so shortlived; but is sometimes seen to live two years, and many times three years together.

All Ephemeras, of which there are various kinds, are produced from the egg, in the form of worms; whence they change into a more perfect form, namely, that of aurelias, which is a kind of middle state between a worm and a fly: and thence they take their last mutation, which is into a beautiful fly, of longer or shorter duration, according to its kind.

The Ephemera, in its fly state, is a very beautiful winged insect, and has a strong similitude to the butterfly, both from its shape and its wings. It is about the size of a middling butterfly; but its wings differ, in not being covered with the painted dust with which those of butterflies are adorned, and rendered opaque, for they are very transparent and very thin. These insects have four wings, the uppermost of which are much the largest: when the insect is at rest, it generally lays its wings one over the other, on the back. The body is long, being formed of six rings, that are larger at the origin than near the extremity; and from this a tail proceeds, that is longer than all the rest of the fly, and consists sometimes of three threads

of an equal length, or sometimes of two long and one short.



The reptile which is to become a fly, and which is granted so long a term, when compared to its latter duration, is an inhabitant of the water, and bears a very strong resemblance to fishes in many particulars, having gills by which it breathes at the bottom, and also the tapering form of aquatic animals. These insects have six scaly legs, fixed on their corslet. Their head is triangular: the eyes are placed forward, and may be distinguished by their largeness and colour. The mouth is furnished with teeth, and the body consists of six rings; that next the corslet being largest, but growing less and less to the end: the last ring is the shortest, from which the three threads proceed, which are as long as the whole body. Thus we see

that the reptile bears a very strong resemblance to the fly; and only requires wings, to be very near its perfection.

As there are several kinds of this animal, their aurelias are consequently of different colours: some yellow, some brown, and some cream-coloured. Some of these also bore themselves cells at the bottom of the water, from which they never stir out, but feed upon the mud composing the walls of their habitation, in contented captivity; others, on the contrary, range about, go from the bottom to the surface, quit that element entirely to feed upon plants by the river side, and then return to their favourite element for safety and protection.

The peculiar signs whereby to know that these reptiles will change into flies in a short time, consist in a protuberance of the wings on the back. About that time, the smooth and depressed form of the upper part of the body is changed into a more swollen and rounder shape: so that the wings are, in some degree, visible through the external sheath that covers them. As they are not natives of England, he who would see them in their greatest abundance must walk, about sunset, along the banks of the Rhine, or the Seine, near Paris; where, for about three days, in the midst of the summer, he will be astonished at their numbers and assiduity. The thickest descent of the flakes of snow in winter seems not to equal their number; the whole air seems alive with the new-born race, and the earth itself is all over covered with their remains. The aurelias, or reptile insects, that are as yet beneath the surface of the water, wait only for the approach of evening to begin their transformation. The most industrious shake off their old garments about eight o'clock; and those who are the most tardy are transformed before nine.

We have already seen that the operation of change, in

other insects is laborious and painful; but with these nothing seems shorter, or performed with greater ease. The aurelias are scarce lifted above the surface of the water, than their old sheathing skin bursts; and through the cavity which is thus formed a fly issues, whose wings at the same instant are unfolded, and at the same time lift it into the air.

Millions and millions of aurelias rise in this manner to the surface, and at once become flies, and fill every quarter with their flutterings. But all these sports are shortly to have an end; for as the little strangers live but an hour or two, the whole swarm soon falls to the ground, and covers the earth, like a deep snow, for several hundred yards, on every side of the river. Their numbers are then incredible, and every object they touch becomes fatal to them; for they instantly die, if they even hit against each other.

At this time, the males and females are very differently employed. The males, quite inactive, and apparently without desires, seem only born to die: no way like the males of other insects, they neither follow the opposite sex, nor bear any enmity to each other: after fluttering for an hour or two, they drop upon land, without seeming to receive wings for any other purpose but to satisfy an idle curiosity. It is otherwise with the females; they are scarce risen from the surface of the water, and have dried their wings, but they hasten to drop their eggs back again. If they happen also to flutter upon land, they deposit their burthen in the place where they drop.

Of all insects, this appears to be the most prolific; and it would seem that there was a necessity for such a supply, as, in its reptile state, it is the favourite food of every kind of fresh-water fish. It is in vain that these little animals form galleries at the bottom of the river, whence

they seldom remove; many kinds of fish break in upon their retreats, and thin their numbers. For this reason, fishermen are careful to provide themselves with these insects, as the most grateful bait; and thus turn the fish's rapacity to his own destruction.

But, though the usual date of these flies is two or three hours at farthest, there are some kinds that live several days; and one kind in particular, after quitting the water, has another case or skin to get rid of. These are often seen in the fields and woods, distant from the water; but they are more frequently found in its vicinity. They are often found sticking upon walls and trees; and frequently with the head downwards, without changing place, or having any sensible motion. They are then waiting for the moment when they shall be divested of their last incommodious garment, which sometimes does not happen for two or three days together.

CHAPTER XIV.

*Of Insects of the Third Order....*CATERPILLARS....*Change to the Aurelia.....To the Butterfly.....*MOTHS.....*Singular Cause for the Destruction of Caterpillars....The Swallow-tailed Butterfly...The Painted Lady Butterfly...The Sphinx Carolina....The Elm Moth....The Death's Head Moth.... The* SILKWORM....*Mode of rearing it....Its Changes.*

CATERPILLARS

MAY be easily distinguished from worms or maggots, by the number of their feet; and by their producing butterflies or moths. When the sun calls up vegetation, and vivifies the various eggs of insects, the Caterpillars are the first that are seen, upon almost every vegetable and

tree, eating its leaves, and preparing for a state of greater perfection. They have feet both before and behind; which not only enable them to move forward by a sort of steps made by their fore and hinder parts, but also to climb up vegetables, and to stretch themselves out from the boughs and stalks to reach their food at a distance. All of this class have from eight feet, at the least, to sixteen; and this may serve to distinguish them from the worm tribe, that never have so many. The animal into which they are converted is always a butterfly or a moth; and these are always distinguished from other flies, by having their wings covered over with a painted dust, which gives them such various beauty. The wings of flies are transparent, as we see in the common flesh fly; while those of beetles are hard, like horn: from such the wing of a butterfly may be easily distinguished; and words would obscure their differences.

When the Caterpillar first bursts from the egg, it is small and feeble; its appetites are in proportion to its size, and it seems to make no great consumption: but as it increases in magnitude, it improves in its appetites; so that, in its adult Caterpillar state, it is the most ravenous of all animals whatsoever. A single Caterpillar will eat double its own weight of leaves in a day, and yet seem no way disordered by the meal. What would mankind do, if their oxen or their horses were so voracious?

The body of the Caterpillar, when anatomically considered, is found composed of rings, whose circumference is

pretty near circular or oval. They are generally twelve in number, and are all membranaceous ; by which Caterpillars may be distinguished from any other insect that nearly resembles them in form. The head of the Caterpillar is connected to the first ring by the neck, which is generally so short and contracted that it is scarcely visible. All the covering of the head in Caterpillars seems to consist of shell; and they have neither upper nor under jaw, for they are both placed rather vertically, and each jaw armed with a large thick tooth, which is singly equal to a number. With these the animals devour their food in such amazing quantities; and, with these, some of the kind defend themselves against their enemies. Though the mouth be kept shut, the teeth are always uncovered; and while the insect is in health, they are seldom without employment. Whatever the Caterpillar devours, these teeth serve to chop into small pieces, and render the parts of the leaf fit for swallowing. Many kinds, while they are yet young, eat only the succulent part of the leaf, and leave all the fibres untouched; others, however, attack the whole leaf, and eat it clean away. One may be amused, for a little time, in observing the avidity with which they are seen to feed; some are seen eating the whole day; others have their hours of repast; some choose the night, and others the day. When the Caterpillar attacks a leaf, it places its body in such a manner that the edge of the leaf shall fall between its feet, which keeps it steady while the teeth are employed in cutting it: these fall upon the leaf, somewhat in the manner of a pair of gardener's shears; and every morsel is swallowed as soon as cut. Some Caterpillars feed upon leaves so very narrow, that they are not broader than their mouths; in this case the animal is seen to devour it from the point, as we would eat a radish.

As there are various kinds of Caterpillars, the number

of their feet are various; some having eight and some sixteen. Of these feet, the six foremost are covered with a sort of shining gristle; and are therefore called the shelly legs. The hindmost feet, whatever be their number, are soft and flexible, and are called membranaceous. Caterpillars also, with regard to their external figure, are either smooth or hairy. The skin of the first kind is soft to the touch, or hard, like shagreen; the skin of the latter is hairy, and, as it were, thorny; and generally, if handled, stings like nettles.

Caterpillars, in general, have six small black spots placed on the circumference of the fore ring, and a little to the side of the head. Three of these are larger than the rest, and are convex and transparent: these Reaumur takes to be the eyes of the Caterpillar; however, most of these reptiles have very little occasion for sight, and seem only to be directed by their feeling.

But the parts of the Caterpillar's body which most justly demand our attention are the stigmata, as they are called; or those holes on the sides of its body, through which the animal is supposed to breathe. All along this insect's body, on each side, these holes are easily discoverable. They are eighteen in number, nine on a side, rather nearer the belly than the back; a hole for every ring, of which the animal's body is composed, except the second, the third, and the last. These oval openings may be considered as so many mouths, through which the insect breathes; but with this difference, that as we have but one pair of lungs, the Caterpillar has no less than eighteen. It requires no great anatomical dexterity to discover these lungs in the larger kind of Caterpillars: they appear, at first view, to be hollow cartilaginous tubes, and of the colour of mother-of-pearl. These tubes are often seen to unite with each other; some are perceived to open into the in-

testines: and some go to different parts of the surface of the body. That these vessels serve to convey the air, appears evidently from the famous experiment of Malpighi; who, by stopping up the mouths of the stigmata with oil, quickly suffocated the animal, which was seen to die convulsed the instant after. In order to ascertain his theory, he rubbed oil upon other parts of the insect's body, leaving the stigmata free; 'and this seemed to have no effect upon the animal's health, but it continued to move and eat as usual: he rubbed oil on the stigmata of one side, and the animal underwent a partial convulsion, but recovered soon after. However, it ought to be observed, that air is not so necessary to these as to the nobler ranks of animals, since Caterpillars will live in an exhausted receiver for several days together; and though they seem dead at the bottom, yet, when taken out, recover, and resume their former vivacity.

If the Caterpillar be cut open longitudinally along the back, its intestines will be perceived running directly in a straight line from the mouth to the anus. They resemble a number of small bags opening into each other; and strengthened on both sides by a fleshy cord, by which they are united. These insects are, upon many occasions, seen to cast forth the internal coat of their intestines with their food, in the changes which they so frequently undergo. But the intestines take up but a small part of the animal's body, if compared to the fatty substance in which they are involved. This substance changes its colour when the insect's metamorphosis begins to approach; and from white it is usually seen to become yellow. If to these parts we add the Caterpillar's implements for spinning (for all Caterpillars spin at one time or another), we shall have a rude sketch of this animal's conformation.

The life of a Caterpillar seems one continued succes-

sion of changes; and it is seen to throw off one skin only to assume another; which also is divested in its turn: and thus for eight or ten times successively.

How laborious soever this operation may be, it is performed in the space of a minute; and the animal, having thrown off its old skin, seems to enjoy new vigour, as well as to have acquired colouring and beauty.. Sometimes it happens that it takes a new appearance and colours very different from the old. Those that are hairy still preserve their covering, although their ancient skin seems not to have lost a single hair; every hair appears to have been drawn, like a sword from the scabbard. The fact, however, is, that a new crop of hair grows between the old skin and the new, and probably helps to throw off the external covering.

The Caterpillar having in this manner continued for several days feeding, and at intervals casting its skin, begins at last to prepare for its change into an Aurelia.

Preparatory to this important change, the Caterpillar most usually quits the plant or tree on which it fed; or at least attaches itself to the stalk or the stem, more gladly than the leaves. It forsakes its food, and prepares, by fasting, to undergo its transmutation.

Those of them which are capable of spinning themselves a web set about this operation; those which have already spun, await the change in the best manner they are able. The web or cone, with which some cover themselves, hides the Aurelia contained within from the view; but in others, where it is more transparent, the Caterpillar, when it has done spinning, strikes in the claws of the two feet under the tail, and afterwards forces in the tail itself by contracting those claws, and violently striking the feet one against the other. If, however, they be taken from their web at this time, they appear in a state of great

langour; and, incapable of walking, remain on that spot where they are placed. In this condition they remain one or two days, preparing to change into an Aurelia; somewhat in the manner they made preparations for changing their skin. They then appear with their bodies bent into a bow, which they now and then are seen to straighten: they make no use of their legs; but, if they attempt to change place, do it by the contortions of their body.

In proportion as their change into an Aurelia approaches, their body becomes more and more bent; while their extensions and convulsive contractions become more frequent. The hinder end of the body is the part which the animal first disengages from its Caterpillar skin; that part of the skin remains empty, while the body is drawn up towards the head. In the same manner they disengage themselves from the two succeeding rings; so that the animal is then lodged entirely in the fore part of its Caterpillar covering: that half which is abandoned remains flaccid and empty; while the fore part, on the contrary, is swollen and distended. The animal, having thus quitted the hinder part of its skin, to drive itself up into the fore part, still continues to heave and work as before; so that the skull is soon seen to burst into three pieces, and a longitudinal opening is made in the three first rings of the body, through which the insect thrusts forth its naked body with strong efforts. Thus, at last, it entirely gets free from its Caterpillar skin, and forever forsakes its most odious reptile form.

The Caterpillar, thus stripped of its skin for the last time, is now become an Aurelia, in which the parts of the future Butterfly are all visible; but in so soft a state that the smallest touch can discompose them. The animal is now become helpless and motionless.

Immediately after being stripped of its Caterpillar skin,

it is of a green colour, especially in those parts which are distended by an extraordinary afflux of animal moisture; but in ten or twelve hours after being thus exposed, its parts harden, the air forms its external covering into a firm crust.

From the beautiful and resplendent colour with which it is thus sometimes adorned, some authors have called it a chrysalis, implying a creature made of gold.

The Butterfly does not continue so long under the form of an Aurelia as one would be apt to imagine. In general, those Caterpillars that provide themselves with cones continue within them but a few days after the cone is completely finished. Some, however, remain buried in this artificial covering for eight or nine months, without taking the smallest sustenance during the whole time: and though in the Caterpillar state no animals were so voracious, when thus transformed they appear a miracle of abstinence. In all, sooner or later, the Butterfly bursts from its prison: not only that natural prison which is formed by the skin of the Aurelia, but also from that artificial one of silk, or any other substance in which it has enclosed itself.

If the animal be shut up within a cone, the Butterfly always gets rid of the natural internal skin of the Aurelia before it eats its way through the external covering which its own industry has formed round it. In order to observe the manner in which it thus gets rid of the Aurelia covering, we must cut open the cone, and then we shall have an opportunity of discovering the insect's efforts to emancipate itself from its natural shell. When this operation begins, there seems to be a violent agitation in the humours contained within the little animal's body.

The skin of the head and legs first separates; then the skin at the back flies open, and, dividing into two regular

portions, disengages the back and wings: then there likewise happens another rupture in that portion which covered the rings of the back of the Aurelia. After this, the Butterfly, as if fatigued with its struggles, remains very quiet for some time, with its wings pointed downwards, and its legs fixed in the skin which it has just thrown off. At first sight, the animal, just permitted the use of its wings, seems to want them entirely; they take up such little room, that one would wonder where they were hidden. But, soon after, they expand so rapidly that the eye can scarcely attend their unfolding.

Nor is it their wings alone that are thus increased; all their spots and paintings, before so minute as to be scarcely discernible, are proportionably extended; so that what a few minutes before seemed only a number of confused, unmeaning points, now become distinct and most beautiful ornaments.

The wing, at the instant it is freed from its confinement, is considerably thicker than afterwards; so that it spreads in all its dimensions, growing thinner as it becomes broader. If one of the wings be plucked from the animal just set free, it may be spread by the fingers, and will soon become as broad as the other which has been left behind. As the wings extend themselves so suddenly, they have not yet had time to dry; and accordingly appear like pieces of wet paper, soft and full of wrinkles. In about half an hour they are perfectly dry, their wrinkles entirely disappear, and the liitle animal assumes all its splendour.

The number of these beautiful animals is very great; and though Linnæus has reckoned up above seven hundred and sixty different kinds, the catalogue is still very incomplete. Every collector of Butterflies can show undescribed species, and such as are fond of minute discovery, can here produce animals that have been examined only by

himself. In general, however, those of the warmer climates are larger and more beautiful than such as are bred at home.

The wings of Butterflies, as was observed, fully distinguish them from flies of every other kind. They are four in number; and though two of them be cut off, the animal can fly with the two others remaining. They are, in their own substance, transparent; but owe their opacity to the beautiful dust with which they are covered: if we regard the wing of a Butterfly with a good microscope, we shall perceive it studded over with a variety of little grains of different dimensions and forms, generally supported upon a footstalk, regularly laid upon the whole surface. The wing itself is composed of several membranes, which render the construction very strong, though light; and though it be covered over with thousands of these scales or studs, yet its weight is very little increased by the number. The animal is with ease enabled to support itself a long while in the air, although its flight be not very graceful. When it designs to fly to a considerable distance, it ascends and descends alternately; going sometimes to the right, sometimes to the left, without any apparent reason. Upon closer examination, however, it will be found that it flies thus irregularly in pursuit of its mate: and as dogs bait and quarter the ground in pursuit of their game, so these insects traverse the air, in quest of their mates, whom they can discover at more than a mile distance.

If we prosecute our description of the Butterfly, the animal may be divided into three parts; the head, the corslet, and the body.

The body is the hinder part of the Butterfly, and is composed of rings, which are generally concealed under long hair, with which that part of the animal is clothed. The corslet is more solid than the rest of the body, because the

fore wings, and the legs, are fixed therein. The legs are six in number, although four only are made use of by the animal; the two fore legs being often so much concealed in the long hair of the body, that it is sometimes difficult to discover them.

But leaving the other parts of the Butterfly, let us turn our attention particularly to the head. The eyes of Butterflies have not all the same form; for, in some they are large, in others small; in some they are the largest portion of a sphere, in others they are but a small part of it, and just appearing from the head. In all of them, however, the outward coat has a lustre, in which may be discovered the various colours of the rainbow. When examined a little closely, it will be found to have the appearance of a multiplying glass; having a great number of sides, or facets, in the manner of a brilliant cut diamond. In this particular, the eye of the Butterfly, and of most other insects, entirely correspond; and Leuwenhoek pretends that there are above six thousand facets on the cornea of a flea. These animals, therefore, see not only with great clearness, but view every object multiplied in a surprising manner. Puget adapted the cornea of a fly in such a position as to see objects through it by the means of à microscope; and nothing could exceed the strangeness of its representations; a soldier, who was seen through it, appeared like an army of pigmies; for while it multiplied, it also diminished the object: the arch of a bridge exhibited a spectacle more magnificent than human skill could perform: the flame of a candle seemed a beautiful illumination. It still, however, remains a doubt, whether the insect sees objects singly, as with one eye, or whether every facet is itself a complete eye, exhibiting its own object distinct from all the rest.

Butterflies, as well as most other flying insects, have

two instruments, like horns, on their heads, which are commonly called feelers. They differ from the horns of greater animals, in being moveable at their base; and in having a great number of joints, by which means the insect is enabled to turn them in every direction. Those of Butterflies are placed at the top of the head, pretty near the external edge of each eye. What the use of these instruments may be, which are thus formed with so much art, and by a workman who does nothing without reason, is as yet unknown to man. They may serve to guard the eye; they may be of use to clean it; or they may be the organ of some sense of which we are ignorant; but this is only explaining one difficulty by another.

We are not so ignorant of the uses of the trunk, which few insects of the Butterfly kind are without. This instrument is placed exactly between the eyes; and when the animal is not employed in seeking its nourishment, it is rolled up, like a curl. A Butterfly, when it is feeding, flies round some flower, and settles upon it. The trunk is then uncurled, and thrust out either wholly or in part; and is employed in searching the flower to its very bottom, let it be ever so deep. This search being repeated seven or eight times, the Butterfly then passes to another; and continues to hover over those agreeable to its taste, like a bird over its prey. This trunk consists of two equal hollow tubes, nicely joined to each other, like the pipes of an organ.

This tribe of insects has been divided into diurnal and nocturnal flies; or, more properly speaking, into Butterflies and Moths; the one flying only by day, the other most usually on the wing in the night. They may be easily distinguished from each other, by their horns or feelers; those of the Butterfly being clubbed, or knobbed at the end; those of the Moth, tapering finer and finer to

a point. To express it technically, the feelers of Butterflies are clavated; those of Moths are filiform.

The Butterflies, as well as the Moths, employ the short life assigned them in a variety of enjoyments. Their whole time is spent either in quest of food, which every flower offers; or in the pursuit of the female, whose approach they can often perceive at above two miles distance. Their sagacity in this particular is not less astonishing than true; but by what sense they are thus capable of distinguishing each other at such distances is not easy to conceive. It cannot be by the sight, since such small objects as they are must be utterly imperceptible, at half the distance at which they perceive each other: it can scarcely be by the sense of smelling, since the animal appears to have no organs for that purpose.

The general rule among insects is, that the female is larger than the male; and this obtains particularly in the tribe we are describing. The body of the male is smaller and slenderer; that of the female more thick and oval. The eggs of the female Butterflies are disposed in the body like a bed of chaplets; which, when excluded, are usually oval, and of a whitish colour: some, however, are quite round; and others flatted, like a turnip. The covering or shell of the egg, though solid, is thin and transparent; and in proportion as the caterpillar grows within the egg, the colours change, and are distributed differently. The Butterfly seems very well instructed by nature in its choice of the plant, or leaf, where it shall deposit its burden. Each egg contains but one caterpillar; and it is requisite that this little animal, when excluded, should be near its peculiar provision. All the eggs of Butterflies are attached to the leaves of the favourite plant, by a sort of size or glue; where they continue, unobserved, unless carefully sought after. The eggs are sometimes placed

round the tender shoots of plants, in the form of bracelets, consisting of above two hundred in each, and generally surrounding the shoot, like a ring upon a finger. Some Butterflies secure their eggs from the injuries of air, by covering them with hair, plucked from their own bodies, as birds sometimes are seen to make their nests; so that their eggs are thus kept warm, and also entirely concealed.

The maxim which has been often urged against man, that he, of all other animals, is the only creature that is an enemy to its own kind, and that the human species only are found to destroy each other, has been adopted by persons who never considered the history of insects. Some of the caterpillar kind in particular, that seem fitted only to live upon leaves and plants, will, however, eat each other; and the strongest will devour the weak, in preference to their vegetable food. That which lives upon the oak is found to seize any of its companions, which it conveniently can, by the first rings, and inflict a deadly wound: it then feasts in tranquillity on its prey, and leaves nothing of the animal but the husk.

But it is not from each other they have most to fear, as in general they are inoffensive; and many of this tribe are found to live in a kind of society. Many kinds of flies lay their eggs either upon, or within their bodies; and as these turn into worms, the caterpillar is seen to nourish a set of intestine enemies within its body, that must shortly be its destruction. Nature has taught flies, as well as all other animals, the surest method of perpetuating their kind. "Towards the end of August," says Reaumur, "I perceived a little fly, of a beautiful gold colour, busily employed in the body of a large caterpillar, of that kind which feeds upon cabbage. I gently separated that part of the leaf on which these insects were placed, from the rest of the plant, and placed it where I might observe

them more at my ease. The fly, wholly taken up by the business in which it was employed, walked along the caterpillar's body, now and then remaining fixed to a particular spot. Upon this occasion, I perceived it every now and then dart a sting, which it carried at the end of its tail, into the caterpillar's body, and then drew it out again, to repeat the same operation in another place. It was not difficult for me to conjecture the business which engaged this animal so earnestly; its whole aim was to deposit its eggs in the caterpillar's body; which was to serve as a proper retreat for bringing them to perfection. The reptile thus rudely treated, seemed to bear all very patiently, only moving a little when stung too deeply; which, however, the fly seemed entirely to disregard. I took particular care to feed this caterpillar; which seemed to me to continue as voracious and vigorous as any of the rest of its kind. In about ten or twelve days, it changed into an aurelia, which seemed gradually to decline, and died: upon examining its internal parts, the animal was entirely devoured by worms; which, however, did not come to perfection, as it is probable they had not enough to sustain them within."

THE ELM MOTH.

The wings of this insect are white, with a double row of pale black spots across the middle: a ferruginous brown spot at the base, and another at the posterior margin of the first pair; likewise a similar spot on the interior margin of the second pair.

This species bears some affinity to the Current Moth. It is very rare, and has been hitherto found only in Yorkshire. It appears the third week in June. The larva feeds on the elm; it is green, streaked with black, and has a black head.

THE SWALLOW-TAILED BUTTERFLY,

Which bears the scientific name of ***Papilio Machaon***, is reckoned the most superb of the British species. It is not widely diffused, but occurs in the New Forest, and near Beverly and Bristol. The wings are tailed, with both surfaces alike; yellow with a brown border, in which are yellow lanules; the angle of the tail is fulvous. The larva feed on umbelliferous plants; the caterpillar is green, banded with black, marked with a row of red spots. There

are two broods, of which the first appears in May, having all the winter been in the pupa state; the second comes forth in August.

THE PAINTED LADY BUTTERFLY

Is a species not very common. In some seasons, these insects appear in considerable numbers, and then again are not seen for several years. In point of beauty, this

has the highest claim of all; its wings are indented, orange above, variegated with black and white beneath; four eyes on the posterior pair Its larva feeds on nettles, thistles,

docks, and other herbage, by the sides of ditches, and changes its state about the middle or latter end of July.

THE SPHINX CAROLINA.

The larva of this scarce Moth is green, with lateral spiracles on every segment, surrounded by a purple ring; and the caudal spine is of the same colour. When full grown, they are thickest in the middle; their horn or tongue is generally curled; and they have two feelers.

Their wings are clouded, entire, and the posterior margin is dotted with white; the abdomen has five pairs of fulvous spots.

In America, they are sometimes distinguished by the

name of Tobacco Moths, on account of their feeding entirely on that plant.

THE DEATH'S HEAD MOTH.

THIS beautiful insect, whose scientific name is the *Sphinx Atropos*, is one of the rarest of the Moths, and is found only in warm places. It alights on particular flowers, among which are the jasmine, the potato, and the wild solanums. Of its four wings, the feathers of which are particularly fine and glossy, the upper pair are of a rich dark gray, marked with white and orange; while the under pair are of a glowing orange, with irregular black bands. The upper part of the abdomen is orange barred with black. The most remarkable part of this insect, however, is a sort of representation of a death's head, which appears on the superior portion of the thorax. This is formed by a large irregular gray patch, having two black dots near the middle.

Such an appearance cannot, of course, be regarded without terror by the superstitious. It has, accordingly, often excited great alarm, and is even yet viewed with dislike by many persons. In one instance, all the

nuns of a convent were thrown into consternation, by one of these insects having flown in through a window. Nay, a whole province has looked upon the Sphinx Atropos as the bringer of death. In Brittany the inhabitants were at one time afflicted with an epidemic disorder, which was often fatal, and unusual numbers of these insects having appeared at the same period, the people believed that they came to announce their destruction, and the Royal Academy was consulted, as to whether the Moths might not be the cause of the disease.

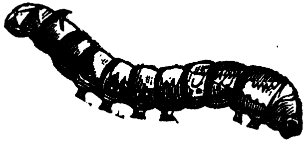
When hurt, the Sphinx Atropos utters a dismal and melancholy cry, like that of a mouse; and this contributes to make it still more an object of dread.

The caterpillar of this Moth is almost unequalled in this country for size and beauty. It is between four and five inches long, bright in colour, and with conspicuous antennæ and eyes. A brilliant yellow is the prevailing hue, with a row of transverse stripes, azure and violet, on each side. The ends of the stripes, towards the back, are pointed, and there are black dots, which the country people consider as eyes. The caterpillar excites in the ignorant and superstitious almost as much alarm as the Moth.

THE SILKWORM.

Though silk was anciently brought in small quantities to Rome, yet it was so scarce as to be sold for its weight in gold; and was considered such a luxurious refinement in dress, that it was infamous for a man to appear in habits of which silk formed but half the composition. The emperor Aurelian refused his empress a silken robe, on account of its being too expensive. It was most probably brought among them from the remotest parts of the East; since it was, at the time of which we are speaking, scarcely

known even in Persia. The insect that forms it is indigenous to the East Indies and China, and to those countries the manufacturer was confined in ancient times. The Romans entertained the most erroneous ideas with respect to the manner in which it is produced.



The Silkworm is a large caterpillar, of a whitish colour, with twelve feet, and producing a butterfly of the moth kind. There are two methods of breeding Silkworms; for they may be left to grow, and remain at liberty upon the trees where they are hatched; or they may be kept in a place built for that purpose, fed every day with fresh leaves. The first method is used in China, Tonquin, and other hot countries; but to breed them in Europe, they must be sheltered and protected from every external injury. For this purpose, a room is chosen, with a south aspect; and the windows are so well glazed, as not to admit the least air; the walls are well built, and the planks of the floor exceeding close, so as to admit neither birds nor mice, nor even so much as an insect. In the middle there should be four pillars erected, or four wooden posts, so placed as to form a pretty large square. Between these are different stories made with osier hurdles; and under each hurdle there should be a floor, with an upright border all round. These hurdles and floors must hang upon pulleys, so as to be placed or taken down at pleasure.

When the worms are hatched, some tender mulberry leaves are provided, and placed in the cloth or paper box in which the eggs were laid, and which are large enough

to hold a great number. When they have acquired some strength, they must be distributed on beds of mulberry leaves, in the different stories of the square in the middle of the room, round which a person may freely pass on every side. They will fix themselves to the leaves, and afterwards to the sticks of the hurdles, when the leaves are devoured. They have then a thread, by which they can suspend themselves on occasion, to prevent any shock by a fall. Care must be taken that fresh leaves be brought every morning, which must be strewed very gently and equally over them; upon which the Silkworms will forsake the remainder of the old leaves, which must be carefully taken away, and every thing kept very clean; for nothing hurts these insects so much as moisture and uncleanliness. For this reason, the leaves must be gathered when the weather is dry, and kept in a dry place, if it be necessary to lay in a store. As these animals have but a short time to live, they make use of every moment, and almost continually are spinning, except at those intervals when they change their skins. If mulberry leaves be difficult to be obtained, the leaves of lettuce or hollyhock will sustain them; but they do not thrive so well upon their new diet; and their silk will neither be so copious, nor of so good a quality.

Though the judicious choice and careful management of their diet is absolutely necessary, yet there is another precaution of equal importance, which is to give them air, and open their chamber windows, at such times as the sun shines warmest.

The worm at the time it bursts the shell is extremely small, and of a black colour; but the head is of a more shining black than the rest of the body; some days after, they begin to turn whitish, or of an ash coloured gray. After the skin begins to grow too rigid, or the animal is stint-

ed with it, the insect throws it off, and appears clothed anew: it then becomes larger and much whiter, though it has a greenish cast. After some days, which are more or less, according to the different heat of the climate, or to the quality of the food, it leaves off eating, and seems to sleep for two days together: then it begins to stir, and puts itself into violent motions, till the skin falls off the second time, and is thrown aside at the animal's feet. All these changes are made in three weeks or a month's time; after which it begins to feed once more, still in its caterpillar form, but a good deal differing from itself before its change. In a few days time it seems to sleep again; and, when it awakes, it again changes its clothing, and continues feeding as before. When it has thus taken a sufficiency of food, and its parts are disposed for assuming the aurelia form, the animal forsakes, for the last time, all food and society, and prepares itself a retreat to defend it from external injuries, while it is seemingly deprived of life and motion.

This retreat is no other than its cone or ball of silk, which nature has taught it to compose with great art; and within which it buries itself, till it assumes its winged form. This cone or ball is spun from two little longish kinds of bags that lie above the intestines, and are filled with a gummy fluid, of a marigold colour. This is the substance of which the threads are formed; and the little animal is furnished with a surprising apparatus for spinning it to the degree of fineness which its occasions may require. This instrument in some measure resembles a wire-drawer's machine, in which gold or silver threads are drawn to any degree of minuteness; and through this the animal draws its thread with great assiduity. As every thread proceeds from two gum bags, it is probable that each supplies its own; which, however, are united, as they

proceed from the animal's body. If we examine the thread with a microscope it will be found that it is flatted on each side, and grooved along its length: whence we may infer, that it is doubled just upon leaving the body; and that the two threads stick to each other by that gummy quality of which they are possessed. Previous to spinning its web, the Silkworm seeks out some convenient place to erect its cell, without any obstruction. When it has found a leaf, on a chink fitted to its purpose, it begins to writhe its head in every direction, and fastens its thread on every side to the sides of its retreat. Though all its first essays seem perfectly confused, yet they are not altogether without design; there appears indeed no order or contrivance in the disposal of its first threads: they are by no means laid artfully over each other; but are thrown out at random, to serve as an external shelter against rain; for nature having appointed the animal to work upon trees in the open air, its habits remain, though it is brought up in a warm apartment.

Malpighi pretends to have observed six different layers in a single cone of silk: but what may be easily observed is, that it is composed externally of a kind of rough cotton-like substance, which is called floss; within, the thread is more distinct and even; and next the body of the aurelia, the apartment seems lined with a substance of the hardness of paper, but of a much stronger consistence. It must not be supposed, that the thread which goes to compose the cone, is rolled round, as we roll a bobbin; on the contrary, it lies upon it in a very irregular manner, and winds off now from one side of the cone, and then from the other. This whole thread, if measured, will be found about three hundred yards long: and so fine, that eight or ten of them are generally rolled off into one by the manufacturer. The cone, when completed, is in form like a pigeon's

egg, and more pointed at one end than the other: at the smaller end, the head of the aurelia is generally found; and this is the place that the insect, when converted into a moth, is generally seen to burst through.

It is generally a fortnight or three weeks before the aurelia is changed into a moth; but no sooner is the winged

insect completely formed, than, having divested itself of its aurelia skin, it prepares to burst through its cone, or outward prison; for this purpose it extends its head towards the point of the cone, butts with its eyes, which are rough, against the lining of its cell, wears it away, and at last pushes forward, through a passage which is small at first, but which enlarges as the animal increases its efforts for emancipation; while the tattered remnants of its aurelia skin lie in confusion within the cone, like a bundle of dirty linen.

The animal, when thus set free from its double confinement, appears exhausted with fatigue, and seems produced for no other purpose but to transmit a future brood. It neither flies nor eats: there are few, however, of these animals suffered to come to a state of maturity; for as their bursting through the cone destroys the silk, the manufacturers take care to kill the aurelia, by exposing it to the sun, before the moth comes to perfection. This done, they take off the floss, and throw the cones into warm water, stirring them till the first thread offers them a clue for winding all off. They generally take eight of the silken

threads together; the cones being still kept under water till a proper quantity of the silk is wound off; however, they do not take all; for the latter parts grow weak, and, are of a bad colour. As to the paperlike substance which remains, some stain it with a variety of colours, to make artificial flowers, others let it lie in the water, till the glutinous matter which cements it is all dissolved: it is then carded like wool, spun with a wheel, and converted into silk stuffs of an inferior kind.

CHAP. XV.

Of the Fourth Order of Insects...The BEE...*The Foreign Bees...Humble Bee...The Wood Bee...The Mason Bee...The Ground Bee...The Leaf-cutting Bee...The Wall Bee...The Yellow hairy Bee...The* WASP...*The Hornet...The Solitary Wasp...The Ichneumon Fly...The Ant...The Termites...The Sugar Ants...The South American Ants...The New Holland Ants...The* BEETLE...*The May Bug...The Great Stag Beetle...The Tumble-dung...The King of the Beetles...The Elephant Beetle...The Gigantic Cockroach...The Burying Sylph...The Diamond Beetle...The Great Water Beetle... The Glow-worm...The Cantharides...The Kermes...The Cochineal...The Gall Insect...The* GNAT...*The* TIPULA... *The* GAD FLY.

IN the foregoing part we treated of caterpillars changing into butterflies; in the present will be given the history of grubs changing into their corresponding winged animals. These, like the former, undergo their transformation, and appear as grubs or maggots, and at last as winged insects. Some of these have four transparent wings, as Bees; some have two membraneous cases to their wings, as Beetles; and some have but two wings, which are transparent, as Ants.

THE BEE.

Drone. Queen. Working Bee.

The Domestic Bee differs in a variety of particulars from most other animals, and admits a threefold description; under its various characters of *Queen Bee*, *Drone Bee*, and *Working Bee*; for though this last kind is, strictly speaking, the only Honey Bee, yet as all the three kinds are found, and seem to be necessary, in every community or hive of Bees, they go under the same general name of *Apis Mellifica*, while at the same time they differ so much from each other (more indeed than some different species of the same genus of other animals), that a particular and separate description of each is necessary. The Drones may easily be distinguished from the common or working Bees. They are both larger and longer in the body. Their heads are round, their eyes full, and their tongues short. The form of the belly differs from those of both queen and common Bees; and their colour is darker than either. They have no sting, and they make a much greater noise when flying than either the queen or the common Bees; a peculiarity of itself sufficient to distinguish them. Other writers on this subject have asserted, that the dissection of the drone gives as great proof of its being the male, as that of the queen does of her being female. In this creature there is no appearance of ovaries or eggs, nor any thing of the structure of the common working Bees, but the whole abdomen

is filled with transparent vessels, winding about in various sinuosities, and containing a white or milky fluid. This is plainly analogous to that fluid in the males of other animals, which is destined to render the eggs of the female prolific; and the whole apparatus of vessels, which much resemble the turnings and windings of the seminal vessels in other animals, is plainly intended only for the preparation and retention of this matter, till the destined time of its being emitted. On squeezing the hinder parts, also, may be forced out the penis, a small and slender fleshy body, contained between two horns of a somewhat harder substance, which join at their base, but gradually part asunder as they are continued in length. These parts, found in all the drones, and none of them in any other Bees except these, seem to prove very evidently the difference of sex. *If a hive is opened in the beginning of spring, not a single drone will be found in it; from the middle of May till the end of June hundreds of them will be found, commonly from two hundred or three hundred to one thousand; but from August to the following spring it would be in vain to seek for them. They go not out till eleven in the morning, and return before six in the evening. But their expeditions are not those of industry. Their rostrum and feet are not adapted for collecting wax and honey, nor indeed are they obliged to labour. They only hover upon flowers to extract the sweets, and all their business is pleasure. Their office is, to impregnate the eggs of the queen after they are deposited in the cells. And while their presence is thus necessary, they are suffered to enjoy the sweets of love and life; but as soon as they become useless in the hive, the working Bees declare a war of extermination against them, and make terrible slaughter of them. This war affects not only the drones already in life, but even the eggs and maggots in the drone cells; for after the season proper for increas-

ing the number of Bees is past, every vestige of the drones is destroyed, to make room for honey.

The QUEEN is easily distinguished from all the other Bees in the hive, by the form, size, and colour of her body. She is considerably longer, and her wings are much shorter, in proportion to her body, than those of the other Bees. The wings of both common Bees and drones cover their whole bodies, whereas those of the queen scarcely reach beyond the middle, ending about the third ring of the belly. Her hinder part is far more tapering than those of the other Bees: her belly or legs are yellower, and her upper parts of a much darker colour than theirs. She is also furnished with a sting, though some authors assert that she has none, having been induced to form this opinion because she is extremely pacific; so much so indeed, that one may handle her, and even tease her as much as he pleases, without provoking her resentment. The omniscient Governor of nature has wisely ordained this majestic insect to be of a pacific disposition; for, were she otherwise, were she like the other Bees of so irritable a temper as to draw her sting on every occasion, and to leave it in the body of her antagonist, it would prove of dangerous and often fatal consequence to the whole hive; for every bee, after losing her sting, dies within a day or two at the utmost. The queen Bee is solemn and calm in her deportment. A young queen is a great deal smaller in size than a full grown one; being not much longer than a common Bee, and is therefore not so easily observed when sought for. When only three or four days old, she is very quick in her motions, and runs very fast; but when pregnant with eggs, she becomes very large, and her body is heavy.

The WORKING OR COMMON BEE is smaller than either the queen or the drone Bee; and, as well as these, consists of three parts, viz. the head, which is attached by a narrow

kind of neck to the rest of the body; the breast, or middle part; and the belly, which is nearly separated from the breast by an insection or division, and connected with it by another narrow neck or junction. There are two eyes in the head, of an oblong figure, black, transparent, and immoveable. The mouth and jaws, like those of some species of fish, open to the right and left, and serve instead of hands to carry out of the hive whatever encumbers or offends them. In the mouth there is a long proboscis, or trunk, with which the Bees suck up the sweets from the flowers. They have four wings fastened to their middle part, by which they are not only enabled to fly with heavy loads, but also to make those well known sounds and hummings to each other that are supposed to be their only form of speech. They have also six legs fastened to their middle. The two foremost of these are the shortest, and with these they unload themselves of their treasures. The two in the middle are somewhat longer; and the two last are longest. On the outside of the middle joint of these last, there is a small cavity in the form of a narrow spoon, in which the Bees collect by degrees those loads of wax they carry home to their hives. This hollow groove is peculiar to the working Bee. Neither the queen nor the drones have any resemblance of it. The tibiæ of the hind legs are ciliated, and transversely streaked on the inside. Each foot terminates in two hooks, with their points opposite to each other; in the middle of these hooks there is a little thin appendix, which, when unfolded, enables the insects to fasten themselves to glass, or the most polished bodies. This part they likewise employ for transmitting the small particles of crude wax which they find upon flowers, to the cavity in their thighs. The belly is ornamented with six rings; and contains, besides the intestines, the honey-bladder, the venom-bladder, and the sting. The

honey-bladder is a reservoir, into which is deposited the honey that the Bee sips from the cups of the flowers after it has passed through the proboscis, and through the narrow pipes that connect the head, breast, and belly of the Bee. This bladder, when full, is of the size of a small pea, and is so transparent, that the colour of the honey can be distinguished through it. The sting is situated at the extremity of the belly, and the head or root of it is placed contiguous to the small bladder that contains the venom, connected to the belly by certain small muscles, by means of which the Bee can dart it out and draw it in with great force and quickness. In length it is about the sixth part of an inch. These working Bees may be said to compose the whole community, except in the season of the drones, which hardly lasts three months. During all the other nine months there are no other Bees in the hive except them and the queen. The whole labour of the hive is performed by them. They build the combs, collect the honey, bring it home, and store it up in their waxen magazines. They rear up the eggs to produce young queens, common bees, and drones; they carry out all incumbrances that are in the hives; they defend the community against enemies of every kind, and kill all the drones.

With regard to the age of Bees, the large drones live but a little while, being destroyed without mercy by the working Bees, probably to save honey. As to the age of the working Bees, writers are not agreed. Some maintain that they are annual, and others suppose that they live many years. Many of them, it is well known, die annually of hard labour; and though they may be preserved by succession in hives or colonies for several years, the most accurate observers are of opinion, that their age is but a year, or at the utmost not more than two summers.

"These industrious insects," Mr. Bonner remarks, "have their vices as well as their virtues. The most savage Indian tribes do not wage more deadly wars than the Bees of different hives, and sometimes of the same hive, occasionally do. In these battles, their stings are their chief weapons; and great skill may be discovered in their manner of pointing them between the scaly rings which cover their bodies, or to some other easily vulnerable part. The Bee which first gains the advantage remains the conqueror; though the victory costs the victor his life, if he has left his sting in the body of the enemy; for with the sting so much of the body is torn out, that death inevitably follows. Bees have very severe conflicts when whole hives engage in a pitched battle, and many are slain on both sides."

Mr. Wildman, by his dexterity in the management of Bees, some years ago surprised the whole kingdom. He caused swarms to light where he pleased almost instantaneously; he ordered them to settle on his head, then removed them to his hand, and commanded them to depart and settle on a window, table, &c. at pleasure. We subjoin the method of preforming these feats, in his own words: "Long experience has taught me, that as soon as I turn up a hive, and give it some taps on the sides and bottom, the queen immediately appears to know the cause of this alarm; but soon retires again among her people. Being accustomed to see her so often, I readily perceive her at first glance; and long practice has enabled me to seize her instantly, with a tenderness that does not in the least endanger her person. This is of the utmost importance; for the least injury done to her brings immediate destruction to the hive, if you have not a spare queen to put in her place, as I have too often experienced in my first attempts. When possessed of her I can, without injury to her, or exciting that degree of resentment that may

tempt her to sting me, slip her into my other hand, and returning the hive to its place, hold her there till the Bees missing her, are all on the wing and in the utmost confusion. When the Bees are thus distressed, I place the queen wherever I would have the Bees to settle. The moment a few of them discover her, they give notice to those near them, and those to the rest; the knowledge of which soon becomes so general that in a few minutes they all collect themselves round her; and are so happy in having recovered this sole support of their state, that they will long remain quiet in their situation. Nay, the scent of her body is so attractive to them, that the slightest touch of her, along any place or substance, will attach the Bees to it, and induce them to pursue any path she takes." This was the only witchcraft used by Mr. Wildman, and is that alone which is practised by others who have since made similar exhibitions.

When the Bees begin to work in their hives, they divide themselves into four companies: one of which roves in the fields in search of materials; another employs itself in laying out the bottom and partitions of their cells; a third is employed in making the inside smooth from the corners and angles; and the fourth company brings food for the rest, or relieves those who return with their respective burdens. But they are not kept constant to one employment; they often change the tasks assigned them; those that have been at work being permitted to go abroad, and those that have been in the fields already take their places. They seem even to have signs by which they understand each other; for when any of them want food, it bends down its trunk to the Bee from whom it is expected, which then opens its honey bag, and lets some drops fall into the other's mouth, which is at that time open to receive it. Their diligence and labour are so great, that in

a day's time they are able to make cells, which lie upon each other, numerous enough to contain three thousand Bees. In the plan and formation of these cells they discover a most wonderful sagacity. In constructing habitations within a limited compass, an architect would have three objects in view; first, to use the smallest possible quantity of materials; next, to give the edifice the greatest capacity in a determined space; and thirdly, to employ the spot in such a manner that none of it may be lost. On examination it will be found that the Bees have obtained all these advantages in the hexagonal form of their cells; for, first, there is economy of wax, as the circumference of one cell makes part of the circumferences of those contiguous to it; secondly, the economy of the spot, as these cells, which join to one another, leave no void between them; and, thirdly, the greatest capacity or space; as of all the figures which can be contiguous, that with six sides gives the largest area. This thriftiness prompts them to make the partitions of their cells thin; yet they are constructed so that the solidity may compensate for the scantiness of materials. The parts most liable to injury are the entrances of the cells. These the Bees take care to strengthen, by adding quite round the circumference of the apertures a fillet of wax, by which means the mouth is three or four times thicker than the sides; and they are strengthened at the bottom by the angle formed by the bottom of three cells falling in the middle of an opposite cell. The combs lie parallel to each other; and there is left between every one of them a space which serves as a street, broad enough for two Bees to pass by each other. There are holes which go quite through the combs, and serve as lanes for the Bees to pass from one comb to another, without being obliged to go a great way about. When they begin their combs, they form at the top of the

hive a root or stay to the whole edifice, which is to hang from it. Though they generally lay the foundations of the combs so that there shall be no more space between them than what is sufficient for two Bees to pass, yet they sometimes place those beginnings of two combs too far asunder; and in this case, in order to fill up part of the void space arising from that bad disposition, they carry their combs on obliquely, to make them gradually approach each other. This void space is sometimes so considerable that the Bees build in it an intermediate comb, which they terminate as soon as the original combs have only their due distances. As the combs would be apt, when full, to overcome by their weight all the security which the Bees can give them against falling, they who prepare hives set in them, crossways, sticks which serve as props to the combs, and save the Bees a great deal of labour. It is not easy to discover the particular manner of their working; for, notwithstanding the many contrivances used for this purpose, there are such numbers in continual motion, and succeeding one another with such rapidity, that nothing but confusion appears to the sight. Some of them, however, have been observed carrying pieces of wax in their talons, and running to the places where they are at work upon the combs. These they fasten to the work by means of the same talons. Each Bee is employed but a very short time in this way; but there is so great a number of them that go on in a constant succession, that the comb increases very perceptibly. Besides these, there are others that run about beating the work with their wings and the hinder parts of their body, probably with a view to make it more firm and solid. Whilst part of the Bees are occupied in forming the cells, others are employed in perfecting and polishing those that are new-modelled. The operation is performed by their

talons, taking off every thing that is rough and uneven. These polishers are not so desultory in their operations as those that make the cells; they work long and diligently, never intermitting their labour, except to carry out of the cell the particles of wax which they take off in polishing. These particles are not allowed to be lost; others are ready to receive them from the polishers, and to employ them in some other part of the work.

One of the chief uses of the cells is to be nurseries for the young. The cells for those who are to be working Bees are commonly half an inch deep; those for drones three quarters of an inch; and those which are intended only for keeping honey still deeper. This accounts for the inequalities observed in the surface of combs. The queen Bee is generally concealed in the most secret part of the hive, and is never visible but when she lays her eggs in such combs as are exposed to sight. When she does appear, she is always attended by ten or a dozen of the common sort, who form a kind of retinue, and follow her, wherever she goes, with a sedate and grave step. Before she lays her eggs, she examines the cells where she designs to lay them; and if she finds that they contain neither honey, wax, nor embryo, she introduces the posterior part of her body into a cell, and fixes to the bottom of it a small white egg, which is composed of a thin white membrane, full of a whitish liquor. In this manner she goes on till she fills as many cells as she has eggs to lay, which are generally many thousands. Sometimes more than one egg has been deposited in the same cell; when this is the case, the working Bees remove the supernumerary eggs, and leave only one in each cell. On the first or second day after the egg is lodged in the cell, the drone Bee, or, according to Mr. Bonner, the working Bee, injects a small quantity of whitish liquid, which in

about a day is absorbed by the egg. On the third or fourth day is produced a worm or maggot; which, when it is grown so as to touch the opposite angle, coils itself up in the shape of a semicircle, and floats in a proper liquid whereby it is nourished and enlarged in its dimensions. This liquor is of a whitish colour, of the thickness of cream, and of an insipid taste, like flour and water. Naturalists are not agreed as to the origin and qualities of this liquid. Some have supposed that it consists of some generative matter, injected by the working Bees into each cell, in order to give fecundity to the egg: but the most probable opinion is, that it is the same with what some writers have called the bee-bread; and that it is a mixture of water with the juices of plants and flowers, collected merely for the nutrition of the young whilst they are in their weak and helpless state. Whatever be the nature of this aliment, it is certain that the working Bees are very industrious in supplying the worms with a sufficient quantity of it. The worm is fed by the working Bees for about eight days, till one end touches the other in the form of a ring; and, when it begins to feel itself uneasy in its first posture, it ceases to eat and begins to unroll itself, thrusting that end forwards to the mouth of the cell which is to be the head. The attendant Bees, observing these symptoms of approaching transformation, desist from their labours in carrying proper food, and employ themselves in fastening up the top of the cell, with a lid of wax, formed in concentric circles, and in cherishing the brood and hastening the birth by their natural heat. In this concealed state the worm extends itself at full length, and prepares a web of a sort of silk, in the manner of the silkworm. This web forms a complete lining for the cell, and affords a convenient receptacle for the transformation of the worm into a nymph or chrysalis. In the space of

eighteen or twenty days the whole process of transformation is finished, and the Bee endeavours to discharge itself from confinement, by forcing an aperture with its teeth through the covering of the cell. The passage is gradually dilated; so that one horn first appears, then the head, and afterwards the whole body. This is usually the work of three hours, and sometimes of half a day. The Bee, after it has disengaged itself, stands on the surface of the comb till it has acquired its natural complexion, and full maturity and strength, so as to become fit for labour. The rest of the Bees gather round it in this state, congratulate it on its birth, and offer it honey out of their own mouths. The exuviæ and scattered pieces of wax which are left in the cell are removed by the working Bees; and the matrix is no sooner cleansed and fit for new fecundation, but the queen deposits another egg in it; insomuch that Mr. Maraldi says, he has seen five Bees produced in the same cell in the space of three months. The young Bees are easily distinguished from the others by their colour; they are gray, instead of the yellowish brown of the common Bees. The reason of this is, that their body is black, and the hairs that grow upon it are white, from the mixture of which seen together results a gray; but this colour forms itself into a brownish colour by degrees, the rings of the body becoming more brown, and the hairs more yellow. The eggs from which drones are to proceed are, as already observed, laid in larger cells than those of the working Bees. The coverings of these cells, when the drones are in the nymph state, are convex or swelling outward, whilst the cells of the working Bees are flat. This, with the privilege of leading idle effeminate lives, and not working for the public stock, is what distinguishes the drones. The Bees depart from their usual style of building when they are to raise cells for bringing up such maggots as

are destined to become queens. These are of a longish oblong form, having one end bigger than the other, with their exterior surface full of little cavities. Wax, which is employed with so geometrical a thriftiness in the raising of hexagonal cells, is expended with profusion in the cell which is to be the cradle of a royal maggot. They sometimes fix it in the middle, and at other times on one side of a comb. Several common cells are sacrificed to serve as a basis and support to it. It is placed almost perpendicular to the common cells, the largest end being uppermost. The lower end is opened till the season for closing it comes, or till the maggot is ready for transformation. It would be difficult to conceive how a tender maggot can remain in a cell turned bottom upmost, if we did not find it buried in a substance scarcely fluid, and if it was not in itself, at first, small and light enough to be suspended in this clammy paste. As it grows it fills all the upper and larger part of the cell. As soon as the young queen comes out of her cell, that cell is destroyed, and its place is supplied by common cells; but, as the foundation of the royal cell is left, this part of the comb is found thicker than any other. There are several such cells prepared; for, if there was only one reared in each hive, the swarms might often want a conductress. Many accidents might also destroy the little maggot before it becomes a Bee. It is, therefore, necessary that a number of such cells should be provided; and accordingly there are observed several young queens in the beginning of the summer, more than one of which often takes flight when a swarm departs. A young queen is in a condition to lead a swarm, from a hive in which she was born, in four or five days after she has appeared in it with wings. The Bees of a swarm are in a great hurry when they know that their queen is ready to lay. In this case they give

their new cells but part of the depth they are to have, and defer the finishing of them till they have traced the number of cells requisite for the present time. The cells first made are intended only for working Bees; these being the most necessary.

Besides the instincts above mentioned, Bees are possessed of others, some of which are equally necessary for their preservation and happiness. They anxiously provide against the entrance of insects into the hive, by gluing up with wax or propolis the smallest holes in it. Some stand as sentinels at the mouth of the hive, to prevent insects of any kind from getting in. But if a snail or other large insect should get in, notwithstanding all resistance, they sting it to death; and then cover it over with a coat of propolis, to prevent the bad smell or maggots which might proceed from the putrefaction of such a large animal. Bees seem to be warned of the appearance of bad weather by some particular feeling. It sometimes happens, even when they are very assiduous and busy, that they on a sudden cease from their work; not a single Bee stirs out; and those that that are abroad hurry home in such prodigious crowds, that the doors of their habitations are too small to admit them. On such occasions, if we look up to the sky, we shall soon discover some of those black clouds which denote impending rain. Whether they see the clouds gathering, as some imagine, or whether (as is more probable) they feel some peculiar sensation upon their bodies, is not yet determinėd; but it is alleged, that no Bee is ever caught even in what we call a sudden shower, unless it has been at a very great distance from the hive, or has been before injured by some accident, orbe sickly and unable to fly so fast as the rest. Cold is very hurtful to Bees. To defend themselves against its effects during a hard winter, they crowd together in the middle of a hive,

and buzz about, and thereby excite a warmth, which is often perceptible by laying the hand upon the glass windows of the hive. They seem to understand one another by the motions of their wings: when the queen wants to quit the hive, she gives a little buzz; and all the others immediately follow her example, and retire along with her.

Honey is originally a juice digested in plants, which sweats through their pores, and chiefly in their flowers, or is contained in reservoirs in which nature stores it. The Bees sometimes penetrate into these stores, and at other times find the liquor exuded. This they collect in their stomachs; so that, when loaded with it, they seem, to an attentive eye, to come home without any booty at all. Besides the liquor already mentioned, which is obtained from the flowers of plants, another substance, called honey dew, has been discovered, of which the Bees are equally fond. From whatever source the Bees have collected their honey, the instant they return home, they seek cells in which they may disgorge and deposit their loads. They have two sorts of stores; one of which consists of honey laid up for the winter, and the other of honey intended for accidental use in case of bad weather, and for such Bees as do not go abroad in search of it. Their method of securing each of these is different. They have in each cell a thicker substance, which is placed over the honey to prevent its running out of the cell; and that substance is raised gradually as the cell is filled, till the Bees, finding that that the cell cannot contain any more, close it with a covering of wax, not to be opened till times of want, r during the winter.

The queen and working Bees are armed with stings; when the whole sting is examined by a microscope along with a small needle, which has received the finest polish

that human art can give it, the sting exhibits all over the most beautiful polish, without the least flaw, blemish, or inequality; while the needle appears full of holes, scratches, and ruggedness, like an iron bar from a smith's forge. Yet this fine polished instrument is only the sheath of others still more exquisitely fine and curious. This fine horny sheath, or scabbard, includes two bearded darts. This sheath ends in a sharp point, near the extremity of which a slit opens, through which, at the time of stinging, the two bearded darts are protruded beyond the end of the sheath: one of these is a little longer than the other, and fixes its beard first; and the other instantly following, they penetrate alternately deeper and deeper, taking hold of the flesh with their beards or hooks, till the whole sting is buried in the flesh; and then a venomous juice is injected through the sheath, from a little bag at the root of the sting. Hence the wound occasions an acute pain and swelling of the part, which sometimes continues several days. These effects are best remedied by enlarging the wound directly, to give it some discharge. This poison seems to owe its mischievous efficacy to certain pungent salts. Let a Bee be provoked to strike its sting against a plate of glass, and there will be a drop of the poison discharged and left upon the glass. This being placed under a double microscope, as the liquor evaporates the salt will be seen to concentrate, forming oblong, pointed, clear crystals. Mr. Derham counted on the sting of a wasp eight beards on the side of each dart, somewhat like the beards of fish-hooks; and the same number is to be counted on the darts of the Bee's sting. When these beards are stuck deep in the flesh, if the wounded person starts, or discomposes the Bee before it can disengage them, the sting is left behind sticking in the wound: but if he have patience to stand quiet, the creature brings the hooks down close to the

sides of the darts, and withdraws the weapons, in which case the wound is always much less painful. The danger of being stung by Bees may be in a great manner prevented by a quiet composed behaviour. A thousand Bees will fly and buzz about a person without hurting him, if he stand perfectly still and forbear disturbing them even when near his face, in which case he may observe them for hours together without danger; but if he molests or beats them away, he usually suffers for it. It has been affirmed, that a person is in perfect safety in the midst of myriads of Bees, if he but carefully keep his mouth shut, and breathe gently through the nostrils only; the human breath, it would seem, being peculiarly offensive to their delicate organs: and, merely with this precaution, the hives may be turned up, and even part of the comb cut out, while the Bees are at work.

When a hive is become too much crowded by the addition of the young brood, a part of the Bees think of finding themselves a more commodious habitation; and with that view single out the most forward of the young queens. A new swarm is, therefore, constantly composed of one queen at least, and of several thousand working Bees, as well as of some hundreds of drones. The working Bees are some old, some young. Scarce has the colony arrived at its new habitation, when the working Bees labour with the utmost diligence to procure materials for food and building. Their principal aim is not only to have cells in which to deposit their honey, but a stronger motive seems to animate them; they seem to know that their queen is in haste to lay her eggs. Their industry is such, that in twenty-four hours they will have made combs twenty inches long, and wide in proportion. They make more wax, during the first fortnight, if the season is favourable, than they do during all the rest of the year. Other Bees are at the same time busy in stopping all the holes and crevi-

ces they find in the new hive, in order to guard against the entrance of insects which covet their honey, their wax or themselves; and also to exclude the cold air; for it is indispensably necessary that they be lodged warm. When the Bees first settle in swarming; indeed, when they at any time rest themselves, there is something very particular in the method of taking their repose. It is done by collecting themselves in a heap, and hanging to each other by their feet. They sometimes extend these heaps to a considerable length. It would seem probable to us, that the Bees from which the others hang must have a considerable weight suspended to them. All that can be said is, that the Bees must find this to be a situation agreeable to themselves. They, perhaps, have a method of distending themselves with the air, thereby to lessen their specific gravity; as fishes do, to alter their gravity compared with water. When a swarm divides into two or more bands, which settle separately, this division is a sure sign that there are two or more queens among them. One of these clusters is generally larger than the other. The Bees of the smaller cluster, or clusters, detach themselves by little and little, till at last the whole, together with the queen or queens, unite with the larger cluster. As soon as the Bees are settled, the supernumerary queen or queens must be sacrificed to the peace and tranquillity of the hive. This execution generally raises a considerable commotion in the hive; and several other Bees, as well as the queen or queens, lose their lives. Their bodies may be observed on the ground near the hive. The queen that is chosen is of a more reddish colour than those which are destroyed; so that fruitfulness seems to be a great motive of preference in Bees; for the nearer they are to the time of laying their eggs, the bigger, redder, and more shining are their bodies.

The balls which we see attached to the legs of Bees returning to the hives, are not wax, but a powder collected from the stamina of flowers, not yet brought to the state of wax. The substance of these balls, heated in any vessel, does not melt as wax would do, but becomes dry, and hardens; it may even be reduced to a coal. If thrown into water it will sink, whereas wax swims. To reduce this crude substance into wax, it must first be digested in the body of the Bee. Every Bee, when it leaves the hive to collect this precious store, enters into the cup of the flower, particularly such as seem charged with the greatest quantity of this yellow farina. As the animal's body is covered over with hair, it rolls itself within the flower, and quickly becomes quite covered with the dust, which it soon after brushes off with its two hind legs, and kneads it into two little balls. In the thighs of the hinder legs there are two cavities edged with hair; and into these, as into a basket, the animal sticks its pellets. Thus employed, the Bee flits from flower to flower, increasing its store, and adding to its stock of wax, until the ball on each thigh becomes as big as a grain of pepper; by this time having got a sufficient load, it returns, making the best of its way to the hive. After the Bees have brought home this crude substance, they eat it by degrees; or, at other times, three or four Bees come and ease the loaded Bee, by eating each of them a share, the loaded Bee giving them a hint so to do. Hunger is not the motive of their thus eating the balls of waxy matter, especially when a swarm is first hived; but it is their desire to provide a speedy supply of real wax for making the combs. At other times, when there is no immediate want of wax, the Bees lay this matter up in repositories to keep it in store. When this waxy matter is swallowed, it is by the digestive powers of the Bee converted into real wax, which the Bees again dis-

gorge as they work it up into combs; for it is only while thus soft and pliant from the stomach, that they can fabricate it properly. That the wax thus employed is taken from their stomach, appears from their making a considerable quantity of comb soon after they are hived, and even on any tree or shrub where they have rested but a short while before their being hived; though no balls were visible on their legs, excepting those of a few which may be just returned from the field. This is farther confirmed by what happened in a swarm newly hived; for two days together, from the time of their quitting their former home, it rained constantly, insomuch that not one Bee was able to stir out during that time; yet, at the end of two days, they had made a comb fifteen or sixteen inches long, and thick in proportion. The crude wax, when brought home to the Bees, is often of as different colours as are the flowers from which it is collected; but the new combs are always of a white colour, which is afterwards changed only by the impurities arising from the steam, &c. of the Bees. Bees collect crude wax also for food; for, if this was not the case, there would be no want of wax after the combs are made; but they are observed, even in old hives, to return in great numbers loaded, with such matter, which is deposited in particular cells, and is known by the name of bee-bread.

Their organs of nutrition, or those by which they collect and appropriate food, are extremely complex; comprising instruments adapted to the reception of liquid, as well as those fitted for the division of solid aliments. For the former purpose they are provided, in common with all hymenopterous insects, with a long and flexible proboscis or trunk, which may be considered as a lengthened tongue, though, strictly speaking, it is formed by a prolongation of the under lip. It is not tubular, as Swammerdam had sup-

posed, but solid throughout; and the minute depression at its extremity is not the aperture of any canal through which liquids can be absorbed. Cuvier, in his Leçons d'Anatomie Comparée, has not marked this distinguishing feature in the proboscis of the Bee, but speaks of it in common with the tubular trunks of the other hymenoptera, and describes its aperture as being situated in the lower part. But Reaumur has very satisfactorily shown, that the trunk of the Bee performs strictly the office of a tongue, and not that of a tube for suction; for when it takes up honey or other fluid aliment, the under or the upper surfaces are more immediately applied to it, and rolled from side to side, and the Bee thus licks up what adheres to it, while the extremity of the trunk is frequently not applied at all to the substance taken up. The trunk is supported on a pedicle which admits of being bent back, or propelled forwards, and thus can retract or stretch out the trunk to a considerable extent. Protection is given to it by a double sheath; the external consisting of two scales furnished by the expansion of one of the portions of the labial palpi, and the internal formed by the prolongation of the two external portions of the jaw. The whole member thus consists of five principal parts, on which account Fabricius termed it lingua quinquefida.

For the purpose of dividing solid materials, the mouth is furnished with two strong mandibles and four palpi, of great use in enabling the insect to seize and break down hard substances. In the working Bee these are of larger dimensions than in the other kinds. The teeth are two in number, and have the form of concave scales with sharp edges; they are fixed to the ends of the jaws, and play horizontally as in other insects. Reaumur describes and delineates a large aperture above the root of the proboscis, which is so surrounded with fleshy parts as not to be readily

seen, unless the proboscis be extended and bent downwards This he considers as the mouth or orifice of the gullet; on the upper side of which, and opposite to the root of the proboscis, a small fleshy and pointed organ is seen, which he regards as the tongue, assisting in the deglutition of the food. Through this orifice, it is presumed, all the aliment, whether liquid or solid, passes; the former being conveyed to it by the trunk, which, by its contractile power, presses forward the fluids it has collected between itself and the inner sheath, and the latter being received directly after its comminution by the teeth, behind which it is situated. Latreille, however, whose authority is great on a point of this nature, thinks that Reaumur has deceived himself with regard to such an aperture, and disbelieves its existence. He conceives that the food simply passes on by the sides of the tongue, finding its way from thence into the œsophagus, and so on to the stomach.

The Bee has two stomachs; the first a large transparent membranous bag, pointed in front, and swelling out into two pouches behind. It performs an office, in some respects, analogous to that of the crop in birds; for it receives and retains for a time, the fluid of the nectarea which does not appear to differ in any respect from honey Mr. Hunter observes, that, whatever time the contents of this reservoir may be retained, he never found them altered, so as to give the idea of digestion having taken place. The coats of this reservoir are muscular, by which means it is capable of throwing up the honey into the mouth, so that it is regurgitated into the honey cells, or imparted to other Bees. None of it ever passes out from the extremity of the trunk, as Swammerdam had believed. For the purpose of digestion a second stomach is provided, which takes its origin from the middle of the two posterior lobes

fo the former, and is of a lengthened cylindrical shape. Its communication with the intestine is not direct, but takes place by a projecting or inverted pylorus, thickest at its most projecting part, with a very small opening in the eentre, of a peculiar construction. This inward projecting part, is easily seen through the coats of the reservoir, especially if full of honey. A similar kind of structure takes place at the communication of the first with the second stomachs, and, having the properties of a valve, must effectually prevent all regurgitation from the latter into the former.

The physiology of their external senses, though a subject of the long-continued observation of naturalists, is very imperfectly understood. They possess, it is clear, organs appropriated to unknown kinds of impressions, and which must open to them avenues to knowledge of various kinds, to which we must be ever total strangers. Who will compare our thermometers, electroscopes, or hygrometers, however elaborately constructed, with those refined instruments with which the lower classes, and particularly insects, appear to be so liberally provided? The antennæ, so universally met with in this class of animals, are doubtless organs of the greatest importance in conveying impressions from without. Their continual motion, the constant use which is made of them in examining objects, the total derangement in the instincts of those insects which have been deprived of them, point them out as exquisite organs of more than one sense. To impressions of touch, arising from the immediate contact of bodies, they are highly sensible; but their motions evidently show that they are affected by distant objects. They are no doubt alive to all the tremulous motions of the air, and probably communicate perceptions of its other qualities. Exceedingly flexible in every direction, they can readily embrace

the outline of any body that the Bee wishes to examine, however small its diameter, and follow all its movements. It is by means of these instruments that the Bee is enabled to execute so many works in the interior of the hive, from which the light must be totally excluded; and, aided by them, it builds combs, pours honey into its magazines, feeds the larvæ, and ministers to all those wants which it discovers and judges of solely by this species of touch. The antennæ are also the principal means of mutual communication, and constitute a sort of language which appears to be susceptible of a great variety of modifications, and of supplying every species of information. It is in this way they satisfy themselves of the presence of their queen, or communicate the alarming intelligence of her absence. On many occasions, the sense residing in the antennæ appears to be supplementary to that of vision, which in Bees is less perfect at night than in many larger animals. During the night, therefore, they are chiefly guided in their movements by this sense. It is singular to observe by moonlight the mode in which Bees guard the entrance of the hive against the intrusion of moths which flutter in the neighbourhood. As vigilant sentinels they extend their antennæ at this time to the utmost, moving them alternately to the right and to the left. Woe to the unfortunate moth that comes within their reach. The moths adroitly endeavor to avoid the slightest contact, and to insinuate themselves between the Bees, so as to get unperceived into the hive, where they riot upon the honey. In full daylight Bees appear to enjoy the sense of vision in great perfection. They will recognize their own habitations from a great distance, and distinguish them at once from many others. On quitting the hive, it flies towards the field which is most in flower; and, as soon as it has determined on its course, it takes as direct a line as a ball issu-

ing from a musket. When it has collected sufficient provision, it rises in the air to discover its hive, and then darts forward with the velocity of an arrow, and with unerring precision in its aim. Their perceptions of heat and cold, generally referred to the sense of touch, appear to be extremely delicate. In several experiments of Huber's, the influence of the rays of the sun excited them to a vigorous action of the wings. It is well known that great cold reduces them to a state of torpor, and inferior degrees of it are evidently unpleasant to them. By their conduct they show that they are sensible of alterations in the weather for some time before we can perceive them. Sometimes, as we have before mentioned, all the working Bees that are abroad hurry home; while we, in the mean time, can distinguish no alteration in the state of the atmosphere. Huber supposes that it is the rapid diminution of light that alarms them; for if the sky be uniformly overcast, they proceed on their excursions, and even the first drops of a soft shower do not make them return with any great precipitation.

Their taste is rather singularly the most imperfect of their senses. They exert hardly any discrimination in the collection of honey, being not repelled by the scent or flavour of such flowers as are extremely offensive to our organs, and not scrupling to derive supplies from such as are highly poisonous. The qualities of honey are, indeed, observed to vary much, according to the particular situation from which it is obtained. The most stagnant and putrid waters are resorted to by Bees with the same avidity as the purest; and in the selection of flowers they are guided by the quantity of honey they expect to meet with, and in no respect by its quality. When the scythe has cut down all the flowers which before yielded them a plentiful supply, they discontinue their excursions, although the weather be

in all respects propitious. Their smell must therefore enable them to discover the presence of honey at great distances. Direct experiment has indeed proved this to be the case. Mr. Huber found that they proceeded immediately towards boxes which contained honey concealed from their view; and such in fact is the situation of the fluid of the nectarea in flowers. Some odours, especially the fumes of tobacco, and indeed all kinds of smoke, are highly obnoxious to them: this is the case also with the smell of oil of turpentine, alcohol, ammonia, the nitric and muriatic acids, and several other volatile chemical agents; upon receiving the impressions of which, they immediately set about ventilating themselves. But nothing excites their displeasure in a greater degree than the breath of a spectator; as soon as they feel which, they show signs of anger, and prepare to revenge it as an insult. The odour of the poison of their sting produces similar effects, exciting them to immediate rage and hostility.

It is sufficiently clear that many insects possess the power of smell, yet the particular organ of this sense has never been ascertained. Various opinions have been supported more by arguments drawn from the analogy of what happens in other classes of animals than by any direct experiment on insects themselves. We know that in all animals respiring by means of lungs, the organs of smell are placed at the entrance of the passages of the air; and it has often been concluded that, in like manner, the stigmata, or the orifices of the air-tubes, were the seat of this sense in insects. By others the antennæ have been assigned as the organs through which these impressions are conveyed to the sensorium. The experiments of Huber have proved that neither of these opinions is correct; and have satisfactorily shown that in the Bee this sense resides in the mouth itself, or in its immediate vicinity. Here indeed

would be its proper station, if this faculty be intended, as we may reasonably suppose it to be, to apprize the individual of the qualities of the food prior to its being eaten. When the mouth of a Bee was plugged up with paste, which was allowed to dry before the insect was set at liberty, it remained quite insensible to the same odours at which it had before manifested the strongest repugnance.

Bees, it is generally supposed, possess the sense of hearing; but the evidence is by no means conclusive; for we find that they are noways disturbed by a loud clap of thunder, or by the report of a gun, or any other noises that may happen to arise around them. It is, however, certain that they are capable of emitting a variety of sounds, which appear expressive of anger, fear, satisfaction, and other passions, and it would seem that they are even capable of communicating certain emotions to one another in this manner. Huber observed that the queens, during their captivity, sent forth a peculiar sound, which he supposes to be a note of lamentation. A certain cry, or humming noise from the queen, also strikes with sudden consternation all the Bees in the hive. Hunter has noticed a number of modulations of sound emitted by Bees under different circumstances, and has instituted an inquiry concerning the means employed by them in producing these sounds, for an account of which see his paper in the Philosophical Transactions.

Buffon refuses to allow Bees any portion of intelligence, and contends that the actions we behold, however admirably they are directed to certain ends, are in fact merely the results of their peculiar mechanism. Other philosophers, such as Reaumur, have gone into the opposite extreme, and have considered them as endued with extraordinary wisdom and foresight, animated by a disinterested patriotism, and a variety of moral and intellectual qualities of high or-

der. The truth, no doubt, lies between these opinions. It appears that Bees possess the faculty of recollecting circumstances and objects at a distant period. "In autumn," says Huber, "honey had been placed in a window, where the Bees resorted to it in multitudes. It was removed, and the shutters closed during winter; but when opened again on the return of spring, the Bees came back, though no honey remained: undoubtedly they remembered it; therefore an interval of several weeks did not obliterate the impression they had received."

On the subject of their fecundation Linnæus seems originally to have suggested the right idea; i. e. that after all that has been said respecting its similarity to that of fishes, an actual union takes place between the queen and the drones. He seems also to have suspected that this union proved fatal to the latter. This opinion has in both points been now verified. In numerous experiments made by Huber during the years 1787 and 1788, he found that the young queens are never impregnated so long as they remain in the interior of the hive: if confined within its walls they continue barren, though amidst a seraglio of males. To receive the approaches of the male the queen soars high in the air, choosing that time of day when the heat has induced the drones to issue from the hive; and love is now ascertained to be the motive of the only distant journey which a young queen ever makes. From this excursion she returns in the space of about half an hour, with the most evident marks of fecundation. The most complete proof of these facts is afforded by the detail of a number of concurring experiments. It is curious that Bonner should have remarked those aërial excursions of the young queens, without ever suspecting their real object, or observing the marks of fecundation upon their return to the hive. M. Huber also assigns a cause for the

existence of such a great number of males. As the queen is obliged to traverse the expanse of the atmosphere, he observes, it is requisite the males should be numerous, that he may have the chance of meeting some one of them. But the reason why impregnation cannot be accomplished within the hive has not yet been ascertained; nor is the cause here assigned for the great number of males quite satisfactory.

M. Huber also states his accidental discovery of the very singular and unexpected consequences which follow from retarding the impregnation of the queen Bee beyond the twentieth or twenty-first day of her life. In the natural order of things, or when impregnation is not retarded, the queen begins to lay the eggs of workers forty-six hours after her intercourse with the male, and she continues for the subsequent eleven months to lay none but these; and it is only after this period, that a considerable and uninterrupted laying of the eggs of drones commences. When, on the contrary, impregnation is retarded after the twentieth day, the queen begins, from the forty-sixth hour, to lay the eggs of drones; and she lays no other kind during her whole life. A single interview with the male, appears sufficient, according to this writer, for fecundifying the whole eggs that a queen will lay in the course of at least two years.

A queen, in ordinary circumstances, lays about three thousand eggs in the space of two months, which is at the rate of fifty a day. It was not correctly ascertained whether the queens, whose impregnation was retarded, laid a number of drone eggs corresponding to the whole number of eggs, both of workers and drones, which they ought to have deposited; but it is certain that they laid a greater number of drone eggs than they ought naturally to have done. The hives in which only drones were pro-

duced, always failed; and, indeed, generally broke up before the queens had done laying; for, after the lapse of some time, the workers finding themselves overwhelmed with drones, "fruges consumere nati," and receiving no increase of their own number, abandoned the hive, and at the same time dispatched their unfortunate sovereign.

In the course of additional experiments, some other curious points in the natural history of the Bee were accidentally illustrated. Thus a queen, twenty-seven days old, having been impregnated on the 31st of October, did not begin to lay at the expiration of forty-six hours, apparently on account of the weather having, in the mean time, become extremely cold. She was confined in a hive all the winter; and, on the 4th of April ensuing, prodigious numbers both of larvæ and pupæ were found; and all of them produced drones.

M. Huber had also an opportunity of correcting those naturalists who maintain that the working Bees are charged with the task of conveying into proper cells such eggs as may be misplaced by the queen. He put a queen, who who was ready to lay workers' eggs, into a prepared hive, which contained only the cells of drones, but which communicated by a narrow tube, sufficient to permit workers to pass, but too small for the queen, with another hive, which contained plenty of the cells of workers. The queen, taught by nature the kinds of eggs she was about to lay, searched about for suitable cells; but, finding none, she chose rather to drop her eggs at random, than place those of workers in the cells of drones. The eggs, thus dropped, soon disappeared: and careless observers might have concluded that they were carried off by the workers to the proper cells; but none were to be seen there; and the author soon ascertained that they were really eaten up by the workers. Thus it was proved, that the care of

depositing properly the respective kinds of eggs is left entirely to the instinct of the queen, and that the workers running off with misplaced eggs, in order to devour them, has been mistaken for their tenderly conveying them to the right cells.

The working Bees had for ages been considered as entirely destitute of sex; and hence, in the writings of many authors, they are denominated neuters. From the experiments of Schirach and of Huber, it seems now to be clearly ascertained that the workers are really of the female sex; but that the organs of generation are small and imperfect, being capable, however, of developement, if the larvæ be fed with royal jelly.

M. Huber confirms the curious discovery of M. Schirach, that when Bees are by any accident deprived of their queen, they have the power of selecting one or two grubs of workers, and of converting them into queens.

M. Huber next relates some experiments which confirm the singular discovery of M. Riems, concerning the existence, occasionally, of common working Bees that are capable of laying eggs; which, we may remark, is certainly a most convincing proof of their being of the female sex.

The origin of these supplementary queens, as they may be called, is accounted for, from their having passed the vermicular state in cells contiguous to the royal ones; and from their having, at an advanced period, devoured some portion of the stimulating jelly which was destined for the nourishment of the royal brood. They are objects of jealousy and animosity to the queen Bee; but how they become impregnated has not been ascertained. It has not, indeed, been directly ascertained that all fertile workers proceed from larvæ that have received portions of the royal food; but M. Huber observed that they were

uniformly such as had passed the vermicular state in cells contiguous to the royal ones. "The Bees," he remarks, "in their course thither, will pass in numbers over them, stop, and drop some portion of the jelly destined for the royal larvæ." This reasoning, though not conclusive, is plausible. The result is so uniform, that M. Huber says, he can, whenever he pleases, produce fertile workers in his hives.

When a supernumerary queen is produced, or introduced into a hive in the course of experiment, either she or the rightful owner soon perishes. The German naturalists, Schirach and Riems, imagined that the working Bees assailed the stranger and stung her to death. Reaumur considered it as more probable, that the sceptre was made to depend on the issue of a single combat between the claimants; and this conjecture is verified by the observations of Huber. The same hostility towards rivals, and destructive vengeance against royal cells, animates all queens, whether they be virgins, or in a state of impregnation, or the mothers of numerous broods. The working Bees, it may here be remarked, remain quiet spectators of the destruction, by the first hatched queen, of the remaining royal cells; they approach only to share in the plunder presented by their havoc-making mistress, greedily devouring any food found at the bottom of the cells, and even sucking the fluid from the abdomen of the nymphs before they toss out the carcasses. The following fact, connected with this subject, is one of the most curious perhaps in the whole history of this wonderful insect; whenever the workers perceive that there are two rival queens in the hive, numbers of them crowd around each; they seem to be perfectly aware of the approaching deadly conflict, and willing to prompt their amazonian chieftains to the battle; for, as often as the queens show a

disinclination to fight, or seem inclined to recede from each other, or to fly off, the Bees immediately surround and detain them; but when either combatant shows a disposition to approach her antagonist, all the Bees forming the clusters instantly give way to allow her full liberty for the attack. It seems strange that those Bees who in general show so much anxiety about the safety of their queen, should, in particular circumstances, oppose her preparations to avoid impending danger—should seem to promote the battle, and to excite the fury of the combatants.

When a queen is removed from a hive, the Bees do not immediately perceive it; they continue their labours, "watch over their young, and perform all their ordinary occupations. But, in a few hours, agitation ensues; all appears a scene of tumult in the hive; singular humming is heard; the Bees desert their young; and rush over the surface of the combs with a delirious impetuosity." They have now evidently discovered that their sovereign is gone; and the rapidity with which the bad news spreads through the hive, to the opposite side of the combs, is very remarkable. On replacing the queen in the hive tranquillity is almost instantly restored. The Bees, it is worthy of notice, recognize the individual person of their own queen. If another be palmed upon them, they seize and surround her, so that she is either suffocated or perishes by hunger; for it is very remarkable, that the workers are never known to attack a queen Bee with their stings. If, however, more than eighteen hours have elapsed before the stranger queen be introduced, she has some chance to escape: the Bees at first seize and confine her; but less rigidly; and they soon begin to disperse, and at length leave her to reign over a hive in which she was at first treated as a prisoner. If twenty-four hours have elapsed, the stran-

ger will be well received from the first, and at once admitted to the sovereignty of the hive. In short, it appears that the Bees when deprived of their queen, are thrown into great agitation; that they wait about twenty hours, apparently in hopes of her return; but that, after this interregnum, the agitation ceases; and they set about supplying their loss by beginning to construct royal cells. It is when they are in this temper, and not sooner, that a stranger queen will be graciously received; and upon her being presented to them, the royal cells, in whatever state of forwardness they may happen to be, are instantly abandoned, and the larvæ destroyed. Reaumur must therefore have mistaken the result of his own experiments, when he asserts, that a stranger queen is instantly well received, though presented at the moment when the other is withdrawn. He had seen the Bees crowding round her at the entrance of the hive, and laying their antennæ over her; and this he seems to have taken for caressing. The structure of the hives he employed prevented him from seeing further: had he used the leaf-hive, or one of similar construction, he would have perceived that the apparent caresses of the guards were only the prelude of actual imprisonment.

After the season of swarming, it is well known, a general massacre of the drones is commenced. Several authors assert that the workers do not sting the drones to death, but merely harass them till they be banished from the hive and perish. M. Huber contrived a glass table, on which he placed several hives, and he was thus able to see distinctly what passed in the bottom of the hive, which is generally dark and concealed: he witnessed a real and furious massacre of the males, the workers thrusting their stings so deep into the bodies of the defenceless drones, that they were obliged to turn on themselves as on a pivot,

before they could extricate them. The work of death commenced in all the hives much about the same time. It is not, however, by a blind or indiscriminating instinct that the workers are impelled thus to sacrifice the males; for if a hive be deprived of its queen, no such massacre takes place in it; but the males are allowed to survive the winter.

A farm, or a country, may be overstocked with Bees, as with any sort of animal; for a certain number of hives always require a certain number of flowers to subsist on. When the flowers near home are rifled, then are these industrious insects seen taking more extensive ranges, but their abilities may be overtaxed; and if they are obliged, in quest of honey, to go too far from home, they are overwearied in the pursuit, they are devoured by birds, or beaten down by the winds and rain.

From a knowledge of this, in some parts of France and Piedmont, they have contrived a kind of floating Bee-house. They have on board one barge threescore or a hundred Bee-hives, well defended from the inclemency of an accidental storm; and with these, the owners suffer themselves to float gently down the river. As the Bees are continually choosing their flowery pasture along the banks of the stream, they are furnished with sweets before unrifled; and thus a single floating Bee-house yields the proprietor a considerable income.

The Bees are nearly alike in all parts of the world, yet there are differences worthy our notice. In Guadaloupe, the Bee is less by one half than the European, and more black and round. They have no sting, and make their cells in hollow trees; where, if the hole they meet with is too large, they form a sort of waxen house, of the shape of a pear, and in this they lodge and store their honey, and lay their eggs. They lay up their honey in waxen vessels of

the size of a pigeon's egg, of a black or deep violet colour; and these are so joined together, that there is no space left between them.

The honey never congeals, but is fluid, of the consistence of oil, and the colour of amber. Resembling these, there are found little black Bees, without a sting, in all the tropical climates; and though these countries are replete with Bees, like our own, yet those form the most useful and laborious tribe in that part of the world. The honey they produce is neither so unpalatable, nor so surfeiting as ours; and the wax is so soft, that it is only used for medicinal purposes, it being never found hard enough to form into candles, as in Europe.

Of insects that receive the name of Bees, among us, there are several; which however differ very widely from that industrious social race we have been just describing. The Humble Bee is the largest of all this tribe, being as large as the first joint of one's middle finger. These are seen in every field, and perched on every flower. They build their nest in holes in the ground, of dry leaves, mixed with wax and wool, defended with moss from the weather. Each Humble Bee makes a separate cell, about the size of a small nutmeg, which is round and hollow, containing the honey in a bag. Several of these cells are joined together, in such a manner, that the whole appears like a cluster of grapes. The females, which have the appearance of wasps, are very few, and their eggs are laid in cells, which the rest soon cover over with wax. It is uncertain whether they have a queen or not; but there is one much larger than the rest, without wings, and without hair, and all over black, like polished ebony. This goes and views all the works, from time to time, and enters into the cell, as if it wanted to see whether every thing was done right: in the morning, the young Humble Bees

are very idle, and seem not at all inclined to labour, till one of the largest, about seven o'clock, thrusts half its body from a hole designed for that purpose, and seated on the top of the nest, beats its wings for twenty minutes successively, buzzing the whole time, till the whole colony is put in motion. The Humble Bees gather honey, as well as the common Bees; but it is neither so fine, nor so good, nor the wax so clean, or so capable of fusion.

Beside the Bees already mentioned, there are various kinds among us, that have much the appearance of honey makers, and yet make only wax. The WOOD BEE, or CARPENTER BEE, is seen in every garden. It is rather larger than the common queen Bee; its body of a bluish black, which is smooth and shining. It begins to appear at the approach of spring, and is seen flying near walls exposed to a sunny aspect. This Bee makes its nest in some piece of wood, which it contrives to scoop and hollow for its purpose. This, however, is never done in trees that are standing, for the wood it makes choice of is half rotten. The holes are not made directly forward, but turning to one side, and have an opening sufficient to admit one's middle finger; whence runs the inner apartment, generally twelve or fifteen inches long. The instruments used in boring these cavities are their teeth; the cavity is usually branched into three or four apartments; and in each of these they lay their eggs, to the number of ten or twelve, each separate and distinct from the rest. The egg is involved in a sort of paste, which serves at once for the young animals protection and nourishment. The grown Bees, however, feed upon small insects, particularly a louse, of a reddish brown colour, of the size of a small pin's head.

MASON BEES make their cells with a sort of mortar made of earth, which they build against a wall that is ex

posed to the sun. The mortar, which at first is soft, soon becomes as hard as stone, and in this their eggs are laid. Each nest contains seven or eight cells, an egg in every cell, placed regularly one over the other. If the nest remains unhurt, or wants but little repairs, they make use of them the year ensuing; and thus they often serve three or four years successively. From the strength of their houses, one would think these Bees in perfect security, yet none are more exposed than they. A worm with very strong teeth is often found to bore into their little fortifications, and devour their young.

The Ground Bee builds its nest in the earth, wherein they make round holes, five or six inches deep; the mouth being narrow, and only just sufficient to admit the little inhabitant. It is amusing enough, to observe the patience and assiduity with which they labour. They carry out all the earth, grain by grain, to the mouth of the hole, where it forms a little hillock, an Alps compared to the power of the artist by which it was raised. Sometimes the walks of a garden are found undermined by their labours; some of the holes running directly downward, others horizontally beneath the surface. They lay up in these cavities provisions for their young, which consist of a paste that has the appearance of corn, and is of a sweetish taste.

The Leaf-cutting Bees make their nest and lay their eggs among bits of leaves, very artificially placed in holes in the earth, of about the length of a toothpick case. They make the bits of leaves of a roundish form, and with them line the inside of their habitations. This tapestry is still further lined by a reddish kind of paste, somewhat sweet or acid. These Bees are of various kinds; those that build their nests with chestnut leaves are as big as drones; but those of the rose-tree are smaller than the common Bee.

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The WALL BEES are so called because they make their nests in walls, of a kind of silky membrane with which they fill up the vacuities between the small stones which form the sides of their habitation. Their apartment consists of several cells, placed end to end, each in the shape of a woman's thimble. Though the web which lines the habitation is thick and warm, yet it is transparent and of a whitish colour. This substance is supposed to be spun from the animal's body: the males and females are of a size, but the former are without a sting.

The YELLOW HAIRY BEE, with a white belly, builds in mossy grounds. The skill displayed by these builders is admirable. In order to enjoy the pleasure of seeing their operations, let a nest be taken to pieces, and the moss conveyed to a distance. The Bees will be seen to form themselves into a chain, from their nest to the place where the moss has been laid. The foremost lays hold of some with her teeth, clears it bit by bit with her feet (which circumstance has also procured them the name of Carding Bees); then, by the help of her feet, she drives the unravelled moss under her belly, the second in like manner pushes it on to the third. Thus there is formed an uninterrupted chain of moss which is wrought and interwoven with the greatest dexterity by those that abide by the nest; and that their nest may not be the sport of the winds, and may shelter them from rain, they throw an arch over it, which they compose with a kind of wax, tenacious, though thin in substance, which is neither the unwrought bees-wax nor the real wax. Dissolved in oil of turpentine, it may be used in taking off impressions.

To these varieties of the Bee kind might be added several others which are all different in nature, but not sufficiently distinguished to excite curiosity.

THE WASP

well known to be a winged insect with a sting; to be ger in proportion to its bulk than the Bee; to be marked th bright yellow circles round its body; and to be the st swift and active insect of all the fly kind. On each e of the mouth this animal is furnished with a long th, notched like a saw, and with these it is enabled to any substance, not omitting meat itself, and to carry it its nest. Wasps live like bees in community, and metimes ten or twelve thousand are found inhabiting a gle nest.

Of all insects the Wasp is the most fierce, voracious, and st dangerous, when enraged. They are seen wher- er flesh is cutting up, gorging themselves with the spoil, d then flying to their nests with their reeking prey. hey make war also on every other fly, and the spider him- lf dreads their approaches.

Every community among bees is composed of females r queens, drones or males, and neutral or working bees. Wasps have similar occupations; the two first are for prop- gating the species, the last for nursing, defending, and supporting the rising progeny. Among bees, however, there is seldom above a queen or two in a hive; among Wasps there are above two or three hundred.

As soon as the summer begins to invigorate the insect tribes, the Wasps are the most of the number, and are diligently employed either in providing provisions for their

nest, if already made, or in making one, if the former habitation be too small to receive the increasing community. The nest is one of the most curious objects in natural history, and contrived almost as artificially as that of the bees themselves. Their principal care is to seek out a hole that has been begun by some other animal, a field mouse, a rat, or a mole, to build their nests in. They sometimes build upon the plain, where they are sure of the dryness of their situation; but most commonly on the side of a bank, to avoid the rain or water that would otherwise annoy them. When they have chosen a proper place, they go to work with wonderful assiduity. Their first labour is to enlarge and widen the hole, taking away the earth, and carrying it off to some distance. To prevent the earth from falling down and crushing their rising city into ruin, they make a sort of roof with their gluey substance, to which they begin to fix the rudiments of their building, working from the top downwards, as if they were hanging a bell, which, however, at length, they close up at the bottom. The materials with which they build their nests, are bits of wood and glue. The wood they get where they can, from the rails and posts which they meet with in the fields, and elsewhere. These they saw and divide into a multitude of small fibres, of which they take up little bundles in their claws, letting fall upon them a few drops of gluey matter with which their bodies are provided, by the help of which they knead the whole composition into a paste, which serves them in their future building. When they have returned with this to the nest, they stick their load of paste on that part where they make their walls and partitions; they tread it close with their feet, and trowel it with their trunks, still going backwards as they work. Having repeated this operation three or four times, the composition is at length flatted out until it becomes a small

leaf of a gray colour, much finer than paper, and of a pretty firm texture. This done, the same Wasp returns to the field to collect a second load of paste, repeating the same several times, placing layer upon layer, and strengthening every partition in proportion to the wants or convenience of the general fabric. Other working Wasps come quickly after to repeat the same operation, laying more leaves upon the former, till at length, after much toil, they have finished the large roof which is to secure them from the tumbling in of the earth. This dome being finished, they make another entrance to their habitation, designed either for letting in the warmth of the sun, or for escaping in case one door be invaded by plunderers. Certain, however, it is, that by one of these they always enter, by the other they sally forth to their toil; each hole being so small that they can pass but one at a time. The walls being thus composed, and the whole somewhat of the shape of a pear, they labour at their cells, which they compose of the same paperlike substance that goes to the formation of the outside works. Their combs differ from those of bees, not less in the composition than the position which they are always seen to obtain. The honeycomb of the bee is edgeways with respect to the hive; that of the Wasp is flat, and the mouth of every cell opens downwards. Thus is their habitation contrived story above story, supported by several rows of pillars which give firmness to the whole building, while the upper story is flat roofed, and as smooth as the pavement of a room laid with squares of marble. The Wasps can freely walk upon these stories between the pillars to do whatever their wants require. The pillars are very hard and compact, being larger at each end than in the middle, not much unlike the columns of a building. All the cells of the nests are only destined

for the recéption of the young, being replete with neither wax nor honey.

Each cell is, like that of the bee, hexagonal; but there are two sorts, the one larger, for the production of the male and the female Wasps, the other less, for the reception of the working part of the community. When the females are impregnated by the males, they lay their eggs one in each cell, and stick it in with a kind of gummy matter to prevent its falling out. From this egg proceeds the insect in its worm state, of which the old ones are extremely careful. But the Wasp community differs from that of the bee in this; that among the latter the working bees take the parental duties upon them, whereas, among the Wasps the females alone are permitted to feed their young, and to nurse their rising progeny. For this purpose the female waits with great patience till the working Wasps have brought in their provisions, which she takes from them, and cuts into pieces. She then goes with great composure from cell to cell, and feeds every young one with her mouth. When the young worms have come to a certain size, they leave off eating, and begin to spin a very fine silk, fixing the first end to the entrance of the cell; then turning their heads, first on one side, then on the other, they fix the thread to different parts, and thus they make a sort of door which serves to close up the mouth of the cell. After this, they divest themselves of their skins after the usual mode of transformation; the aurelia by degrees begins to emancipate itself from its shell, by little and little it thrusts out its legs and wings, and insensibly acquires the colour and shape of its parent.

The Wasp thus formed, and prepared for depredation, becomes a bold, troublesome, and dangerous insect; there are no dangers which it will not encounter in pursuit of its prey, and nothing seems to satiate its gluttony. Though

it can gather no honey of its own, no animal is more fond of sweets. For this purpose, it will pursue the bee and the humble bee, destroy them with its sting, and then plunder them of their honey-bag, with which it flies triumphantly loaded to its nest, to regale its young. Wasps are ever fond of making their nests in the neighbourhood of bees, merely to have an opportunity of robbing their hives, and feasting on the spoil. Yet the bees are not found always patiently submissive to their tyranny, but fierce battles are sometimes seen to ensue, in which the bees make up by conduct and numbers what they want in personal prowess. When there is no honey to be had, they seek for the best and sweetest fruits, and they are never mistaken in their choice. From the garden they fly to the city, to the grocers' shops, and butchers' shambles. They will sometimes carry off bits of flesh half as big as themselves, with which they fly to their nest for the nourishment of their brood. Those who cannot drive them away, lay for them a piece of ox's liver, which being without fibres, they prefer to other flesh; and wherever they are found, all other flies are seen to desert the place immediately. Such is the dread with which these little animals impress all the rest of the insect tribes, which they seize and devour without mercy, that they vanish at their approach. Wherever they fly, like the eagle or the falcon, they form a desert in the air around them. In this manner the summer is passed in plundering the neighbourhood, and rearing up their young; every day adds to their numbers; and from their strength, agility, and indiscriminate appetite for every kind of provision, were they as long lived as the bee, they would soon swarm upon the face of nature, and become the most noxious plague of man: but providentially their lives are measured to their mischief, and they live but a single season. In proportion as the cold of the winter

increases, they are seen to become more domestic; they seldom leave the nest, they make but short adventures from home, they flutter about in the noon-day heats, and soon after return chilled and feeble.

As their calamities increase, new passions soon begin to take place; the care for posterity no longer continues, and as the parents are no longer able to provide their growing progeny a supply, they take the barbarous resolution of sacrificing them all to the necessity of the times. In this manner, like a garrrison upon short allowance, all useless hands are destroyed; the young worms, which a little before they fed and protected with so much assiduity, are now butchered and dragged from their cells. As the cold increases they no longer find sufficient warmth in their nests, which grow hateful to them, and they fly to seek it in the corners of houses, and places that receive an artificial heat. But the winter is still insupportable; and, before the new year begins, they wither and die; the working Wasps first, the males soon following, and many of the females suffering in the general calamity. In every nest, however, one or two females survive the winter, and having been impregnated by the male during the preceding season, she begins in spring to lay her eggs in a little hole of her own contrivance. This bundle of eggs, which is clustered together like grapes, soon produces two worms which the female takes proper precaution to defend and supply, and these when hatched soon give assistance to the female, who is employed in hatching two more; these also gathering strength, extricate themselves out of the web that encloses them; and become likewise assistants to their mother: fifteen days after two more make their appearance: thus is the community every day increasing, while the female lays in every cell, first a male and then a female. These soon after become breeders in turn, till, from a single female,

ten thousand Wasps are seen produced before the month of June.

THE HORNET

Is one of the largest and most remarkable species of the Wasp. It is twice as large as the common Wasp, and is also distinguished by a black breast, and double black spots on the belly; the head is also longer and slenderer, and the eyes somewhat resembling a half moon. It is extrémely bold and venomous. Its predominant passion is for flesh, and when hungry two or three of them will seize upon a small bird, kill it and devour its flesh. Nay, it has even been said, that singly, it will attack and conquer a sparrow. In all its manners and habits, it entirely resembles the Wasps we have been describing.

Such is the history of the social Wasp; but, as among bees, so also among these insects, there are various tribes that live in solitude: these lay their eggs in a hole for the purpose, and the parent dies long before the birth of its offspring. In the principal species of the solitary Wasps, the insect is smaller than the working Wasp of the social kind. The filament, by which the corslet is joined to the

body, is longer and more distinctly seen, and the whole colour of the insect is blacker than in the ordinary kinds. But it is not the figure, but the manners of this extraordinary insect that claim our principal regard.

From the end of May to the beginning of July this Wasp is seen most diligently employed. The whole purpose of its life seems to be in contriving and fitting up a commodious apartment for its young one, which is not to succeed it till the year ensuing. For this end, it is employed, with unwearied assiduity, in boring a hole into the finest earth some inches deep, but not much wider than the diameter of its own body. This is but a gallery leading to a wider apartment, destined for the convenient lodgment of its young. As it always chooses a gravelly soil to work in, and where the earth is almost as hard as stone itself, the digging and hollowing this apartment is an enterprise of no small labour; for effecting its operations, this insect is furnished with two teeth, which are strong and firm, but not sufficiently hard to penetrate the substance through which it is resolved to make its way: in order therefore to soften that earth which it is unable to pierce, it is furnished with a gummy liquor which it emits upon the place, and which renders it more easily separable from the rest, and the whole becoming a kind of soft paste, is removed to the mouth of the habitation. The animal's provision of liquor in these operations is, however, soon exhausted; and it is then seen taking up water from some neighbouring flower or stream, in order to supply the deficiency.

At length, after much toil, a hole some inches deep is formed, at the bottom of which is a large cavity; and to this no other hostile insect would venture to find its way, from the length and the narrowness of the defile through which it would be obliged to pass. In this the solitary

Wasp lays its egg, which is destined to comtinue the species; there the nascent animal is to continue for above nine months, unattended and immured, and at first appearance the most helpless insect of the creation. But when we come to examine, new wonders offer; no other insect can boast so copiously luxuriant a provision, or such confirmed security.

As soon as the mother Wasp has deposited her egg at the bottom of the hole, her next care is to furnish it with a supply of provisions, which may be offered to the young insect as soon as it leaves the egg. To this end, she procures a number of little green worms, generally from eight to twelve, and these are to serve as food for the young one the instant it awakens into life. When this supply is regularly arranged and laid in, the old one, then with as much assiduity as it before worked out its hole, now shuts up the mouth of the passage; and thus leaving its young one enclosed in perfect security, and with a copious supply of animal food, dies, satisfied with having provided for a future progeny.

When the young one leaves the egg it is scarcely visible, and is seen immured among a number of insects, infinitely larger than itself, ranged in proper order around it, which, however, give it no manner of apprehension. Whether the parent, when she has laid in the insect provision, contrived to disable the worms from resistance, or whether they were at first incapable of any, is not known. Certain it is, that the young glutton feasts upon the living spoil without any control; his game lies at his hand, and he devours one after the other, as the calls of appetite incite him. The life of the young animal is, therefore, spent in the most luxurious manner, till its whole stock of worms is exhausted, and the time of its transformation begins to approach; and then spinning a silken web, it continues fix-

ed in its cell till the sun calls it from its dark abode the ensuing summer.

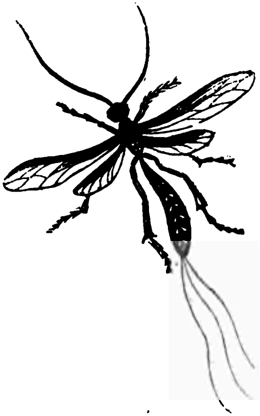
The Wasps of Europe are very mischievous, yet they are innocence itself when compared to those of the tropical climates, where all the insect tribes are not only numerous, but large, voracious, and formidable. Those of the West Indies are thicker, and twice as long as the common bee; they are of a gray colour, striped with yellow, and armed with a very dangerous sting. They make their cells in the manner of a honey-comb, in which the young ones are hatched and bred. They generally hang their nests by threads, composed of the same substance with their cells, to the branches of trees and the eaves of houses. They are seen every where in great abundance, depending like fruit, particularly pears, of which shape they are, and as large as one's head. The inside is divided into three round stories, full of cells, each hexagonal, like those of a honey-comb. In some of the islands these insects are so very numerous, that their nests are stuck up in this manner scarce two feet asunder, and the inhabitants are in continual apprehension from their accidental resentment. It sometimes happens that no precaution can prevent their attacks, and the pain of their sting is almost insupportable. Those who have felt it think it more terrible than even that of a scorpion; the whole visage swells, and the features are so disfigured that a person is scarcely known by his most intimate acquaintance.

THE ICHNEUMON FLY.

Every rank of insects, how voracious soever, have enemies that are terrible to them, and that revenge upon them the injuries done upon the rest of the animated creation. The wasp, as we have seen, is very troublesome to man, and very formidable to the insect tribe; but the Ichneumon

Fly (of which their are many varieties) fears not the wasp itself: it enters its retreats, plunders its habitations, and takes possession of that cell for its own young, which the wasp had laboriously built for a dearer posterity.

This fly receives its name from the little quadruped which is found to be so destructive to the crocodile, as it bears a strong similitude to its courage and rapacity; but though there are many different kinds of this insect, yet the most formidable, and that best known, is called the common Ichneumon, with four wings like the bee, a long



slender black body, and a three-forked tail, consisting of bristles; the two outermost black, and the middlemost red.

Though this instrument is to all appearance slender and feeble, yet it is found to be a weapon of great force and efficacy. There is scarcely any substance which it will not pierce; and, indeed, it is seldom seen but employed in penetration. The male is unprovided with such a sting,

while the female uses it with great force and dexterity, brandishing it when caught, from side to side, and very often wounding those who thought they held her with the greatest security.

All the flies of this tribe are produced in the same manner, and owe their birth to the destruction of some other insect, within whose body they have been deposited, and upon whose vitals they have preyed, till they came to maturity. There is no insect whatever which they will not attack, in order to leave their fatal present in its body; the caterpillar, the gnat, and even the spider himself, so formidable to others, is often made the unwilling fosterer of their destructive progeny.

About the middle of summer, when other insects are found in great abundance, the Ichneumon is seen flying busily about, and seeking proper objects upon whom to deposite its progeny. As there are various kinds of this fly, so they seem to have various appetites. Some are found to place their eggs within the aurelia of some nascent insect, others place them within the nest which the wasp had curiously contrived for its own young; and as both are produced at the same time, the young of the Ichneumon not only devours the young wasp, but the whole supply of worms which the parent had carefully provided for its provision. But the greatest number of the Ichneumon tribe are seen settling upon the back of the caterpillar, and darting, at different intervals, their stings into its body. It often happens, that the caterpillar survives the worm state of the infant Ichneumon, and then they change into a chrysalis, enclosed in its body till the time of their delivery approaches, when they burst their prisons, and fly away. The caterpillar, however, is irreparably destroyed; it never changes into a chrysalis, but dies shortly after, from the injuries it had sustained.

THE ANT.

The common Ants of Europe are of two or three different kinds; some red, some black, some with stings, and others without. Such as have stings inflict their wonnds in that manner; such as are unprovided with these weapons of defence have a power of spurting, from their hinder parts, an acid pungent liquor, which, if it lights upon the skin, inflames and burns it like nettles.

The body of an Ant is divided into the head, breast, and belly. In the head the eyes are placed, which are entirely black, and under the eyes there are two small horns, or feelers, composed of twelve joints, all covered with a fine silky hair. The mouth is furnished with two crooked jaws, which project outwards, in each of which are seen incisors, that look like teeth. The breast is covered with a fine silky hair, from which project six legs, that are pretty strong and hairy, the extremities of each armed with two small claws, which the animal uses in climbing. The belly is more reddish than the rest of the body, which is of a brown chestnut colour, shining as a glass, and covered with extremely fine hair.

As soon as the winter is past, on the first fine day in April, the ant-hill, that before seemed a desert, now swarms with new life, and myriads of these insects are seen just awaked from their annual lethargy, and preparing for the pleasures and fatigues of the season. For the first day they never offer to leave the hill, which may be considered as their citadel, but run over every part of it, as if to examine its present situation, to observe what injuries it has sustained during the rigours of winter, while they slept, and to meditate and settle the labours of the day ensuing.

At the first display of their forces, none but the wing-

less tribe appears, while those furnished with wings remain at the bottom. These are the working Ants, that first appear, and that are always destitute of wings; the males and females, that are furnished with four large wings each, are more slow in making their appearance.

Thus, like bees, they are divided into males and females, and the neutral or working tribe. These are all easily distinguished from each other; the females are much larger than the males; the working Ants are the smallest of all. The two former have wings, which, however, they sometimes are divested of; the latter never have any, and upon them are devolved all the labours that tend to the welfare of the community. The female also may be distinguished by the colour and structure of her breast, which is a little more brown than that of the common Ant, and a little brighter than that of the male.

The neuters exercise all the ordinary offices necessary for the existence and welfare of the community to which they belong; it is they who collect supplies of food, who explore the country for this purpose, and seize upon every animal substance, whether living or dead, which they can lay hold of, and transport to the common abode of the tribe. It is they who construct every part of the dwelling place, who attend the hatching of the eggs, the feeding of the larvæ, and their removal to different situations, as occasion may require, and who conduct all the operations both of offensive and defensive warfare; in fact, all the laborious and perilous duties of this singular commonwealth. There is every reason, however, to believe that the helots and females of this tribe of insects are originally and substantially of the same sex, and that the developement of the sexual organs in the latter is the consequence of some difference in the circumstances in which the larva is placed during its growth. In all the features of internal

structure the supposed neuters agree with the female, and in the number of articulations composing the antennæ. Thus we find thirteen in the male, twelve only in the female, and twelve in the neuter. In the male Ant the abdomen has seven rings, in the female and neuter only six. In the two latter classes the head is broader and the mandibles very large and powerful compared with those of the male, and furnished with serrated edges, and a sharp and often hooked point. The external sexual organs of the female and of the neuter are so nearly similar in appearance, that Latreille declares that he was unable to perceive the least difference between them. On the other hand, it is to be observed, that in the neuter the principal deviation from the model of the female consists in the absence of wings; a circumstance which may be conceived to be connected with a certain condition of the sexual organs, as are the horns of deer and the beard of men.

Ants certainly possess a greater share of muscular strength than almost any other insect of the same size. Of this we are witnesses from childhood in the incessant toil which they undergo, and the great loads they are seen to carry, often exceeding ten or twelve times their own weight. This apparently is connected with a corresponding share of sensation, seen in their great susceptibility to all changes of temperature, to moisture, and other conditions of the atmosphere. In the perfection of their sight they are also remarkable; the males and females being provided with both the descriptions of eyes peculiar to this class, namely, the composite and the simple eyes. The labouring Ants, indeed, who never fly, are frequently destitute of the latter kind.

In all insects the antennæ are organs evidently of the greatest utility in conveying impressions from external

objects. But in the Ant, independently of their importance as organs of touch, they appear to be of still greater consequence, by being the chief instruments which enable them to communicate to one another intelligence in which they are mutually interested, and on which they are called upon to act. Mr. Huber, to whom we are indebted for a variety of curious observations on this subject, has given the name of Antennal Language to this species of intercourse. The situation of the antennæ, which are placed in front of the head, their great mobility, their peculiar mechanism, which presents a series of phalanges having great freedom of play, and endowed with exquisite sensibility, conspire to fit them admirably for the function which he assigns to them—that of producing a variety of different impressions, when applied in different ways to the antennæ, or other parts of those Ants, with which they come in contact. Thus the signal of danger, which consists in the Ant which gives the alarm striking its head against the corslet of the other, is propagated from Ant to Ant with astonishing quickness, throughout the whole society. For a few minutes a general ferment prevails, as if they were deliberating what measures to pursue; but their resolution is soon formed, and they are ready to rush in a body against the enemy. Any small animal that is discovered to have insolently invaded their repose, is certain of falling a victim to their resentment, unless he can make a precipitate retreat, which he seldom effects without being covered with the bites of these furious insects. They are not, however, equally jealous of the intrusion of every kind of insect; for wood-lice are often found in the interior of the nest, to whom, according to Latreille, they offer no molestation. Ants appear to be incapable of emitting sounds so as to communicate with one another at a distance; and there is, indeed, no evidence that they possess the sense of hearing.

Many erroneous opinions are prevalent with regard to the food of Ants, which have often been supposed to consume corn, and to do great injury to plants by devouring their roots or stems. The truth is, that they are chiefly carnivorous insects, preying indiscriminately on all the softer parts of animals, and especially the viscera of other insects, whom they will often attack when alive, and overpower by dint of numbers, upon which they devour their victim on the spot, or drag him prisoner into their nests; or if the game should be too bulky to be easily transported, they make a plentiful meal, and exert like the bee a power of disgorging a portion, and of imparting it to their companions at home. It appears that they are even able to retain at pleasure the nutritious juices unchanged for a considerable time. The rapidity with which they consume, and in fact anatomize, the carcasses of any small bird or quadruped that happens to fall in their way, is well known; and furnishes an easy method of obtaining natural skeletons of these animals, by placing their dead bodies in the vicinity of a populous ant-hill. In hot climates, where they multiply to an amazing extent, their voracity and boldness increase with their numbers. Bosman, in his description of Guinea, states that in one night they will devour a sheep, leaving it a fine skeleton; while a fowl is for them only the amusement of an hour. In these situations they will venture to attack even living animals of considerable size. Rats and mice often become their victims. The sugar Ants of Grenada cleared every plantation which they visited of rats and other vermin, which they probably effected by attacking their young. Poultry, or other small stock, could not be raised without the greatest difficulty; and the eyes, nose, and other emunctories of the bodies of dying or dead animals were instantly covered with them. They generally, indeed, begin their at-

tacks on the most sensible parts, which have the finest cuticle; and, accumulating in great numbers about the nostrils, destroy the animal by interrupting respiration. Negroes with sores had difficulty in keeping the Ants from assailing them. Their power of destruction keeping pace with their increase of numbers, it is hardly possible to assign limits to either; and the united hosts of this diminutive insect have often become formidable to man himself. A story is related by Prevost, in his Histoire Général des Voyages, of an Italian missionary resident in Congo, who was awaked by his negroes in great alarm at the house being invaded by an immense army of Ants, which poured in like a torrent, and before he could rise had already mounted on his legs. They covered the floors and passages, forming a stratum of considerable depth. Nothing but fire was capable of arresting their progress. He states that cows have been known to be devoured in their stalls by these daring devastators. Smith, in his Voyages to Guinea, reports that at Cape Corse the castle was attacked by legions of Ants, who were preceded by thirty or forty, apparently acting as guides. It was at daybreak when they made this incursion, entering first by a chapel, on the floor of which some negro servants were lying. Assailed by this new enemy, they fled with precipitation, and gave the alarm to their master, who, on awaking, could hardly recover from his astonishment at beholding the advancing multitude, which extended for a quarter of a mile before him. There was not much time for deliberation; and a happy expedient was adopted of putting a long train of gunpowder across the line of their march, and extending it to their flanks, which had already began to deploy, and setting fire to the whole, millions were destroyed at one blow; which so intimidated the rest, that the whole army retreated in disorder, and did not renew the attack. At

Sierra Leone, the travelling Ants, or marchers as they are called, will sometimes approach the settlements in lines of two or three miles long; they will cross considerable streams; and, entering a house, are perfectly irresistible except by fire. But even this, many of the inhabitants find it impossible to employ, and allow them to pass through, which they will do in a comparatively short time, clearing the apartments they enter of all other insects.

Ant-hills of immense size are described by travellers who have visited tropical regions. In the forests of Guiana, according to M. Malouet, they attain the height of from fifteen to twenty feet, resembling the rude huts of savages, but containing a race more ferocious than the savage or the tiger himself; for they cannot be approached by men without the utmost danger of being devoured. The new settlers, who, in clearing the country, meet with any of these in their progress, immediately desist from their task, and even abandon the neighbourhood unless they can speedily destroy this formidable enemy. The only method of accomplishing this is to dig a trench all round the ant-hills, and after having filled it with dry wood and set fire to it on every side by lighting it quickly in different places, to cut off all retreat to the Ants, and batter down the edifice.

The only vegetable substance which seems alluring to their appetite is sugar. They not only eat it in substance, but are fond of all fluids that contain it, such as the secretions which exude from many trees, and compose what has been termed the honey-dew; and the saccharine juice, which is excreted from the bodies of many of the insects belonging to the genus aphis. This latter species of food they appear to relish above all others; it resembles honey in its qualities, and is sucked with avidity from the insect which yields it, and which appears in no respect to suffer

from the operation. Boissier de Sauvages was the first who noticed this singular fact; and Mr. P. Huber has ascertained a number of curious circumstances attending it. He conceives that the liquor is given out voluntarily by the aphis, at the solicitation of the Ant, who for this purpose strikes it gently and repeatedly with its antennæ, using the same motions as it does when caressing its young; and remarks that the aphis retains this liquor for a longer time where the Ants are not at hand to receive it. A single aphis may often be seen surrounded by three or four Ants, who are feeding on the honey, and deriving from it a plentiful meal. It does not appear that the aphis uses any exertion to avoid the Ants who are thus dependent on its bounty; for those provided with wings, which would easily enable them to escape, are quite as passive under these circumstances as the rest. These Ants grow torpid when the cold exceeds 27 degrees of Fahrenheit, and in that state require no food; and the aphis affords them sufficient nourishment at other periods of the winter.

In the construction of their nests, each species of Ant employs different materials, and follows its own peculiar mode of construction. Many form them of clay, and particularly the smaller species; one set building up a regular series of apartments in successive stories, often forty in number, with materials which are furnished to them by another set of workers who are excavating the ground. The ceilings are supported throughout by small pillars in some parts, and by vertical walls in others; while broad arches are in other places raised, in order to protect larger spaces, and to admit of lengthened passages of communication throughout a long extent of apartments. These Ants proceed in their building only at such times as the earth has been softened by rain or dew, and the atmosphere is at the same time sufficiently moist to allow of the materials cohering firmly before they dry; and such are

probably the Ants which Pliny mentions as working by moonlight. On one occasion, when the Ants, under the inspection of Mr. Huber, had discontinued their labours on account of too great dryness in the atmosphere, he succeeded in getting them to renew their operations by sprinkling water upon them with a wet brush, in imitation of a natural shower. These insects close the doors of their habitations every night, in order to prevent the intrusion of others; and a few are said to remain on the outside during the night as sentinels.

The fecundation of the Ant is effected very generally during the flight of the females, in which they are accompanied by the males; both appearing to be provided with wings chiefly for this object. A certain number of impregnated females are also, by the assistance of their wings, enabled to reach distant situations, where they become respectively the founders of new colonies; while the males, having fulfilled the office for which nature had destined them, are left to perish on the spot where they descend, being removed from those who formerly administered to them food, and being destitute of the means of procuring subsistence for themselves. Swarms of Ants, of immense size, are occasionally met with; some have been recorded of such prodigious magnitude as to darken the air like a thick cloud, and to cover the ground where they settled to a considerable extent.

The infant colonies consist of very small numbers, and are perhaps wholly the offspring of a common parent, who has migrated alone, or with but a few companions. A number of impregnated females alighting, in the neighbourhood of the nest, are laid hold of by the labouring Ants, who immediately deprive them of their wings, and drag them to the nest, where they keep them prisoners till they deposit their eggs. Each is in the interim respectfully

attended by a numerous retinue of labourers, who are solicitous to anticipate all her wants. When first deposited the eggs are very small, but become considerably larger before the larva is excluded, being apparently nourished by absorption; for the Ants, to whose care they are confided, are continually licking them with their tongues. At the end of a fortnight the larva comes forth, and appears in the form of a transparent maggot, with a head and wings, but without any external organs of motion. They are now fed by their nurses, with a fluid disgorged from their stomachs; and in the course of their whole transformation to the state of nympha, and of perfect insect, are still dependent upon their assistance.

Scenes of ferocious contention are occasionally exhibited between the inhabitants of neighbouring nests, and tend to check their otherwise excessive increase of number. Their weapons of offence are the jaws (which are capable of inflicting a deep bite), and in some species a sting, after using which they instil into the wound a highly acrid liquor. It is extremely volatile and pungent, and is capable of being thrown out by the Ant, when irritated, in considerable quantities. Frogs have been killed by the vapour from an Ant's nest in less than five minutes; and persons breathing it, when of a certain intensity, are nearly suffocated. The most daring and courageous species, such as that which M. Huber calls the Amazon Ant, make it the business of their lives to attack the nests of the weaker Ants, and live by plundering them of their eggs and larvæ. These are hatched and reared by Ants of the same species as themselves, who may be considered as auxiliaries to the Amazons, and who had themselves, at some former period, been kidnapped from their parent nest by the Amazons. Thus a society is formed among different species of insects, to which no parallel exists but in the human race.

TERMITES, OR WHITE ANTS.

Of this curious insect Mr. Smeathman has given, in the Philosophical Transactions, so full and interesting an account, that we cannot do better than quote from it. "Of a great many curious parts of the creation (says he) which I met with in Guinea, the Termites, or White Ants, seemed most worthy of minute attention.

"The size and figure of their buildings have attracted the notice of many travellers, and yet the world has not hitherto been furnished with a tolerable description of them, though, when we come to consider the wonderful order of these insects, and of their subterraneous cities, they will appear foremost on the list of the wonders of the creation.

"These insects are known by various names. They belong to the Termes of Linnæus, and other systematic naturalists.

"By the English, in the windward parts of Africa they are called Bugga Bugs. In the West Indies, Wood Lice, Wood Ants, or White Ants. By the French, at Senegal, Vague Vagues. In the West Indies, Poux de Bois, or Fourmis Blanches. By the Portuguese in the Brazils, Coupée, or Cutters, from their cutting things in pieces. By this latter name, and that of Piercers or Eaters, and similar terms, they are distinguished in various parts of the tropical regions.

"Of every species of the Termites there are three orders; first, the working insects, which I shall call Labourers; next the fighting ones, or Soldiers, which do no kind of labour; and, last of all, the winged ones, or Perfect Insects, which are male and female, and capable of propagation. These might very appositely be called the nobility or gentry, for they neither labour nor fight, being quite incapable of either, and almost of self-defence. These only are capa-

ble of being elected kings or queens; and nature has so ordered it, that they emigrate within a few weeks, after they are elevated to this state, and either establish new kingdoms, or perish within a day or two.

"The Termes Bellicosus, being the largest species,* is best known on the coast of Africa. It erects immense buildings of well tempered clay or earth, which are contrived with such art, that we are at a loss to say, whether they are most to be admired on that account, or for their enormous magnitude and solidity. They not only build larger and more curious nests, but are also more numerous, and do infinitely more mischief to mankind than other species. When these insects attack such things as we would not wish to have injured, we must consider them as most pernicious; but when they are employed in destroying decayed trees and substances which only encumber the surface of the earth, they may be justly supposed very useful. It is apparent to all, who have made observation, that they contribute more to the quick dissolution of putrescent matter than any other. They are so necessary in all hot climates, that even in the open fields a dead animal or small putrid substance cannot be laid upon the ground two minutes before it will be covered with flies and their maggots, which instantly entering quickly devour one part, and perforating the rest in various directions, expose the whole to be much sooner dissipated by the elements. In a few weeks, these insects destroy and carry away the bodies of large trees without leaving a particle behind, thus clearing the place for other vegetables, which soon fill up every vacancy; and in places, where two or three years before there has been a populous town, if the inhabitants, as is

* The other species of this insect, as enumerated by Dr. Solander, are, 2. Termes Mordax; 3. Termes Atrox; 4. Termes Destructor; 5. Termes Arborum.

frequently the case, have chosen to abandon it, there shall be a very thick wood, and not the vestige of a post to be seen, unless the wood has been of a species which, from its hardness, is called iron wood.

"The nests of the Termites Bellicosi are so numerous all over the island of Bananas, and the adjacent continent of Africa, that it is scarce possible to stand upon any open place, where one of these buildings is not to be seen within fifty paces, and frequently two or three are to be seen almost close to each other. In some parts near Senegal, as mentioned by Mons. Adanson, their number, magnitude, and closeness of situation, make them appear like the villages of the natives. These buildings are usually termed hills, from their outward appearance, which is that of little hills more or less conical, and about ten or twelve feet in perpendicular height above the common surface of the ground.

"These hills continue quite bare until they are six or eight feet high: but, in time, the dead barren clay, of which they are composed, becomes fertilized by the genial power of the elements in these prolific climates; and in the second or third year, the hillock, if not overshaded by trees, becomes almost covered with grass and other plants; and in the dry season, when the herbage is burnt up by the rays of the sun, it is not much unlike a very large haycock.

"Every one of these buildings consists of two distinct parts, the exterior and the interior. The exterior is one large shell in the manner of a dome, large and strong enough to shelter the interior from the vicissitudes of the weather, and the inhabitants from the attacks of natural or accidental enemies. It is always, therefore, much stronger than in the interior building, which is the habitable part, divided with a wonderful kind of regularity and contrivance, into an amazing number of apartments for the

residence of the king and queen, and the nursing of their numerous progeny; or for magazines, which are always found well filled with stores and provisions.

"These hills make their first appearance above ground by a little turret or two in the shape of sugar-loaves, which are run a foot high or more. Soon after, at some little distance, while the former are increasing in height and size, they raise others, and so go on increasing the number and widening them at the base, till their works below are covered with these turrets, which they always raise the highest and largest in the middle, and by filling up the intervals between each turret, collect them as it were into one dome. They are made very solid and strong, and when by the junction of them the dome is completed, for which purpose the turrets answer as scaffolds, they take away the middle ones entirely, except the tops (which joined together make the crown of the cupola) and apply the clay to the building of the works within, or to erecting fresh turrets for the purpose of raising the hillock still higher; so that no doubt some part of the clay is used several times, like the boards and posts of a mason's scaffold.

"When these hills are at their full height, they answer excellently as places to look out. I have been with four men on the top of one of these hillocks. Whenever word was brought us of a vessel in sight, we immediately ran to some Bugga Bug hill, as they are called, and clambered up to get a good view, for upon the common surface it was seldom possible to see over the grass or plants.

"The interior parts of these buildings are disposed nearly as follows:

"The royal chamber, which I call so on account of its being occupied by the king and queen, is situated at about a level with the surface of the ground, at an equal distance

from all the sides of the building, and directly under the apex of the hill.

"It is on all sides, both above and below, surrounded by what I should call the royal apartments, which have only labourers and soldiers in them, and can be intended for no other purpose than for these to wait in, either to guard or serve their common father and mother, on whose safety depends the happiness, and, according to the negroes, even the existence, of the whole community. These apartments compose an intricate labyrinth, which extends a foot or more in diameter from the royal chamber on every side. Here the nurseries and magazines of provisions begin, and, being separated by small empty chambers and galleries, which go round them or communicate from one to the other, are continued on all sides to the outward shell, and reach up within it two-thirds or three-fourths of its height, leaving an open area in the middle under the dome, which very much resembles the nave of an old cathedral: this is surrounded by three or four very large Gothic shaped arches, which are sometimes two or three feet high next the front of the area, but diminish very rapidly as they recede from thence like the arches of aisles in perspectives, and are soon lost among the innumerable chambers and nurseries behind them.

"All these chambers, and the passages leading to and from them, being arched, they help to support one another; and while the interior large arches prevent them falling into the centre, and keep the area open, the exterior building supports them on the outside.

"There are, comparatively speaking, few openings into the great area, and they for the most part seem intended only to admit that genial warmth into the nurseries which the dome collects.

"The interior building or assemblage of nurseries, cham-

bers, &c. has a flattish roof without any perforation, which would keep the apartments below dry, in case through accident the dome should receive any injury and let in water; and it is never exactly flat and uniform, because they are always adding to it by building more chambers; so that the divisions or columns between the future arched apartments resemble the pinnacles upon the fronts of some old buildings, and demand particular notice as affording one proof that for the most part the insects project their arches, and do not make them, as I imagined for a long time, by excavation.

"The area has also a flattish floor, which lies over the royal chamber, but sometimes a good height above it, having nurseries and magazines between. It is water-proof, and contrived, as far as I could guess, to let the water off, if it should get in, and run over by some short way into the subterraneous passages which run under the lowest apartments in the hill in various directions, and are of an astonishing size, being wider than the bore of a great cannon. I have a memorandum of one I measured, perfectly cylindrical, and thirteen inches in diameter.

"These subterraneous passages or galleries are lined very thick with the same kind of clay of which the hill is composed, and ascend the inside of the outward shell in a spiral manner, and winding round the whole building up to the top intersect each other at different heights, opening either immediately into the dome in various places, and into the interior building, the new turrets, &c. or communicating thereto by other galleries of different bores or diameters, either circular or oval. From every part of these large galleries are various small pipes or galleries leading to different parts of the building. Under ground there are a great many which lead downward by sloping descents three and four feet perpendicular among the gravel, from whence the labouring Termites cull the finer parts,

which, being worked up in their mouths to the consistence of mortar, becomes that solid clay or stone of which their hills and all their buildings, except their nurseries, are composed. Other galleries again ascend and lead out horizontally on every side, and are carried under ground near to the surface a vast distance: for if you destroy all the nests within one hundred yards of your house, the inhabitants of those, which are left unmolested farther off, will nevertheless carry on their subterraneous galleries and invade the goods and merchandises contained in it by sap and mine, and do great mischief, if you are not very circumspect."

Mr. Smeathman describes some inferior buildings made by other species of the Termites; but nothing very remarkable occurs, till we come to the nests built by the Termites Arborum. These are generally spherical or oval, and built in trees, and very frequently may be seen surrounding the branch of a tree at the height of seventy or eighty feet; and (though but rarely of so large a size) as big as a very great sugar cask.

"The colour of these nests, like that of the roofed turrets, is black, from which, and their irregular surface and orbicular shape, they have been called Negro Heads by our first writers on the Caribbee Islands, and by the French, 'Têtes des Nègres.' See Hunter's Evelyn's Sylva, p. 17. They are composed of small particles of wood and the various gums and juices of trees, combined with, perhaps, those of the animals, and worked by those little industrious creatures into a paste, and so moulded into innumerable little cells of very different and irregular forms, which afford nothing curious, but the immense quantity of inhabitants, young and old, with which they are at all times crowded; on which account they are sought for in order to feed young fowls, and especially for the rearing of turkeys. These nests are very compact, and so strongly at-

tached to the boughs on which they are fixed, that there is no detaching them but by cutting them in pieces, or sawing off the branch; and they will sustain the force of a tornado as long as the tree on which they are fixed.

"The Termites Arborum, those which build in trees, frequently establish their nests within the roofs and other parts of houses, to which they do considerable damage, if not entirely extirpated. The large species are, however, not only much more destructive, but more difficult to be guarded against, since they make their approaches chiefly under ground, descending below the foundations of houses and stores at several feet from the surface, and rising again either in the floors, or entering at the bottom of the posts, of which the sides of the building are composed, bore quite through them, following the course of the fibres to the top, or making lateral perforations and cavities here and there as they proceed.

"While some are employed in gutting the posts, others ascend from them, entering a rafter or some other part of the roof. If they once find the thatch, which seems to be a favourite food, they soon bring up wet clay, and build their pipes or galleries through the roof in various directions, as long as it will support them; sometimes eating the palm-tree leaves and branches of which it is composed, and perhaps the rattan or other running plant which is used as a cord to tie the various parts of the roof together, and that to the posts which support it. Thus, with the assistance of the rats, they very soon ruin the house by weakening the fastenings, and exposing it to the wet. In the mean time, the posts will be perforated in every direction as full of holes as that timber in the bottoms of ships which has been bored by the worms: the fibrous and knotty parts, which are the hardest, being left to the last.*

* The sea-worms, so pernicious to shipping, appear to have the same

"They sometimes, in carrying on this business, find, that the post has some weight to support, and then if it is a convenient track to the roof, or is itself a kind of wood agreeable to them, they bring their mortar, and fill all or most of the cavities, leaving the necessary roads through it, and as fast as they take away the wood replace the vacancy with that material; which being worked together by them closer and more compactly than human strength or art could ram it, when the house is pulled to pieces, in order to examine if any of the posts are fit to be used again, those of the softer kinds are often found reduced almost to a shell, and all or a greater part transformed

office allotted them in the waters which the Termites have on the land. They will appear, on a very little consideration, to be most important beings in the great chain of creation, and pleasing demonstrations of that infinitely wise and gracious power which formed, and still preserves, the whole in such wonderful order and beauty: for, if it was not for the rapacity of these and such animals, tropical rivers, and indeed the ocean itself, would be choked with the bodies of trees which are annually carried down by the rapid torrents, as many of them would last for ages, and probably be productive of evils, of which, happily, we cannot in the present harmonious state of things form any idea; whereas, now being consumed by these animals, they are more easily broken in pieces by waves; and the fragments which are not devoured become specifically lighter, and are consequently more readily and more effectually thrown on shore, where the sun, wind, insects, and various other instruments, speedily promote their entire dissolution.

That wood will endure in water an amazing number of ages, is apparent from the oak stakes which were driven into the bed of the river Thames on the invasion of England by Julius Cæsar, one of which is to be seen in Sir Ashton Lever's Museum, and likewise from those bodies of trees which are daily found in the bogs and morasses of Great Britain and Ireland, which after a duration, the former of eighteen hundred, the latter of upwards of two thousand years, are found in a perfect state of preservation.

from wood to clay as solid and as hard as many kinds of free-stone used for building in England.

"These insects are not less expeditious in destroying the shelves, wainscoting, and other fixtures of a house, than the house itself. They are forever piercing and boring in all directions, and sometimes go out of the broadside of one post into that of another joining to it; but they always destroy the softer substances first, and are particularly fond of pine and fir boards, which they excavate and carry away with wonderful cunning and despatch: for, except a shelf has something standing upon it, as a book, or any thing else which may tempt them, they will not perforate the surface, but artfully preserve it quite whole, and eat away all the inside, except a few fibres which barely keep the two sides connected together, so that a piece of an inch broad, which appears solid to the eye, will not weigh much more than two sheets of pasteboard of equal dimensions, after these animals have been a little while in possession of it. In short, the Termites are so insidious in their attacks, that we cannot be too much on our guard against them: they will sometimes begin and raise their works, especially in new houses, through the floor. If you destroy the work so begun, and make a fire upon the spot, the next night they will attempt to rise through another part; and, if they happen to emerge from under a trunk early in the night, will pierce the bottom, and destroy or spoil every thing in it before the morning. On these accounts we are careful to set all our chests and boxes upon stones or bricks, so as to leave the bottoms of such furniture some inches above the ground.

"When the Termites attack trees and branches in the open air, they sometimes vary their manner of doing it. If a stake in a hedge has not taken root and vegetated, it becomes their business to destroy it. If it has a good sound bark round it, they will enter at the bottom, and eat all

but the bark, which will remain, and exhibit the appearance of a solid stick; but, if they cannot trust the bark, they cover the whole stick with their mortar, and it then looks as if it had been dipped into thick mud that had been dried on. Under this covering they work, leaving no more of the stick and bark than is barely sufficient to support it, and frequently not the smallest particle, so that, upon a very small tap with your walking-stick, the whole stake, though apparently as thick as your arm, and five or six feet long, loses its form, and disappearing like a shadow falls in small fragments at your feet. They generally enter the body of a large tree which has fallen through age or been thrown down by violence, on the side next the ground, and eat away at their leisure within the bark, without giving themselves the trouble either to cover it on the outside, or to replace the wood which they have removed from within, being somehow sensible that there is no necessity for it. These excavated trees have deceived me two or three times in running: for, attempting to step two or three feet high, I might as well have attempted to step upon a cloud, and have come down with such unexpected violence, that, besides shaking my teeth and bones almost to dislocation, I have been precipitated, head foremost, among the neighbouring trees and bushes. Sometimes, though seldom, they attack living trees; but not, I apprehend, before symptoms of mortification have appeared at the roots, since it is evident, as is before observed, that these insects are intended in the order of nature to hasten the dissolution of such trees and vegetables as have arrived at their greatest maturity and perfection, and which would, by a tedious decay, serve only to encumber the face of the earth. This purpose they answer so effectually, that nothing perishable escapes them, and it is almost impossible to leave any thing penetrable upon the ground a long time in safety; for the

odds are, that, put it where you will abroad, they will find it out before the following morning, and its destruction follows very soon."

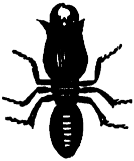
Having thus given some idea of the nests of these wonderful insects, of their uses in the creation, and of the vast mischief they cause to mankind, Mr. Smeathman next describes the insects themselves. This description is introductory to his curious and entertaining account of their economy and management, and of their manner of building, fighting, and marching.

"I have observed before, that there are of every species of Termites three orders. Of these the working insects or labourers are always the most numerous. In the Termites Bellicosus there seem to be at least one hundred labourers to one of the fighting insects or soldiers. The labourers are about one fourth of an inch long, and twenty-five of them weigh about a grain; so that they are not so large as some of our Ants. From their external habit and fondness for wood, they have been very expressively called wood lice. They resemble them, it is true, very much at a distance, but they run faster than any other insects of their size, and are incessantly bustling about their affairs.

"The second order, or Soldiers, have a very different form from the labourers, and have been by some authors supposed to be the males, and the former neuters: but they are, in fact, the same insects as the foregoing, only they have undergone a change of form, and approach one degree nearer to the perfect state. They are now much larger, being half an inch long, and equal in bulk to fifteen of the labourers.

"There is now likewise a most remarkable circumstance in the form of the head and mouth; for in the former state the mouth is evidently calculated for gnawing and holding bodies; but in this state, the jaws being shaped just

like two very sharp awls a little jagged, they are incapable of any thing but piercing or wounding, for which purposes they are very effectual, being as hard as a crab's



claw, and placed in a strong horny head, which is of a nutbrown colour, and larger than all the rest of the body together, which seems to labour under great difficulty in carrying it: on which account perhaps the animal is incapable of climbing up perpendicular surfaces.

"The third order, or the insect in its perfect state, varies its form still more than ever. The head, thorax, and abdomen, differ almost entirely from the same parts in the labourers and soldiers; and, besides this, the animal is now furnished with four large brownish, transparent wings,

with which it is at the time of emigration to wing its way in search of a new settlement. In short, it differs so much from its form and appearance in the other two states, that it has never been supposed to be the same animal, but by those who have seen it in the same nests: and some of these have distrusted the evidence of their senses. It was so long before I met with them in their nests myself, that

I doubted the information that was given me by the natives, that they belonged to the same family. Indeed we may open twenty nests without finding one winged one, for those are to be found only just before the commencement of the rainy season, when they undergo the last change, which is preparative to their colonization.

"In the winged state they have also much altered their size as well as form. Their bodies now measure between six or seven tenths of an inch in length, and their wings above two inches and a half from tip to tip, and they are equal in bulk to about thirty labourers, or two soldiers. They are now also furnished with two large eyes placed on each side of the head, and very conspicuous. If they have any before, they are not easily to be distinguished. Probably in the two first states, their eyes, if they have any, may be small like those of moles; for as they live like these animals always under ground, they have as little occasion for these organs, and it is not to be wondered at that we do not discover them; but the case is much altered when they arrive at the winged state in which they are to roam, though but for a few hours, through the wide air, and explore new and distant regions. In this form the animal comes abroad during or soon after the first tornado, which at the latter end of the dry season proclaims the approach of the ensuing rains, and seldom waits for a second or third shower, if the first, as is generally the case, happens in the night, and brings much wet after it. The quantities that are to be found the next morning all over the surface of the earth, but particularly on the waters, is astonishing; for their wings are only calculated to carry them a few hours, and after the rising of the sun not one in a thousand is to be found with four wings, unless the morning continues rainy, when here and there a solitary being is seen winging its way from one place to another, as if solicitous only to avoid its numerous enemies, particu-

larly various species of ants which are hunting on every spray, on every leaf, and in every possible place, for this unhappy race, of which probably not a pair in many millions get into a place of safety, fulfil the first law of nature, and lay the foundation of a new community.

"Not only all kinds of Ants, birds, and carnivorous reptiles, as well as insects, are upon the hunt for them, but the inhabitants of many countries, and particularly of that part of Africa where I was, eat them. At the time of swarming, or rather of emigration, they fall into the neighbouring waters, when the Africans skim them off with calabashes, bring large kettles full of them to their habitations, and parch them in iron pots over a gentle fire, stirring them about as is usually done in roasting coffee. In that state, without sauce or any other addition, they serve them as delicious food; and they put them by handsfull into their mouths, as we do comfits. I have eaten them dressed this way several times, and think them both delicate, nourishing, and wholesome; they are something sweeter, but not so fat and cloying as the caterpillar or maggot of the palm tree, snout-beetle, curculio palmarum, which is served up at all the luxurious tables of West Indian epicures, particularly of the French, as the greatest dainty of the western world.

"On the following morning, as I have observed, they are to be seen running upon the ground in chase of each other; sometimes with one or two wings still hanging to their bodies, which are not only useless but seem rather cumbersome. The greater part have no wings, but they run exceeding fast, the males after the females. I have sometimes remarked two males after one female, contending with great eagerness who should win the prize, regardless of the innumerable dangers that surrounded them.

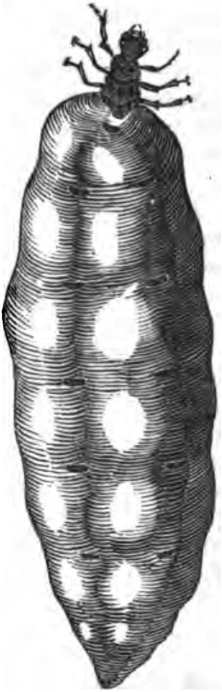
"They are now become from one of the most active, industrious, and rapacious, from one of the most fierce and

implacable little animals in the world, the most innocent, helpless and cowardly; never making the least resistance to the smallest Ant. The Ants are to be seen on every side in infinite numbers, of various species and sizes, dragging these annual victims of the laws of nature to their different nests. It is wonderful that a pair should ever escape so many dangers and get into a place of security. Some, however, are so fortunate; and, being found by some of the labouring insects that are continually running about the surface of the ground under their covered galleries, are elected kings and queens of new states. The manner in which these labourers protect the happy pair, from their innumerable enemies, not only on the day of the massacre of almost all their race, but for a long time after, will, I hope, justify me in the use of the term election. The little industrious creatures immediately enclose them in a small chamber of clay suitable to their size, into which at first they leave but one small entrance, large enough for themselves and the soldiers to go in and out, but much too little for either of the royal pair to make use of; and, when necessity obliges them to make more entrances, they are never larger; so that, of course, the voluntary subjects charge themselves with the task of providing for the offspring of their sovereigns, as well as to work and to fight for them, until they shall have raised a progeny capable at least of dividing the task with them.

"It is not until this time, probably, that they consummate their marriage, as I never saw a pair of them joined. The business of propagation, however, soon commences, and the labourers, having constructed a small wooden nursery, as before described, carry the eggs and lodge them there as fast as they can obtain them from the queen.

"About this time a most extraordinary change begins to take place in the queen, to which I know nothing sim-

er, except in the pulex penetrans of Linnæus, the jigger of the West Indies, and in the different species of coccus, cochineal. The abdomen of this female begins gradually to extend and enlarge to such an enormous size, that an old queen will have it increased so as to be fifteen hundred or two thousand times the bulk of the rest of her body, and twenty or thirty thousand times the bulk of a labourer, as I have found by carefully weighing and computing the different states. The skin between the segments of the abdomen extends in every direction; and at last the segments are removed to half an inch distance from each other, though at first the length of the whole abdomen is not half an inch. They preserve their dark brown colour, and the upper part of the abdomen is marked with a regular series of brown bars from the thorax to the posterior part of the abdomen, while the intervals between them are covered with a thin, delicate, transparent skin, and appear of a fine



cream colour, a little shaded by the dark colour of the intestines and watery fluid seen here and there beneath. I conjecture the animal is upwards of two years old when the abdomen is increased to three inches in length: I have sometimes found them of near twice that size. The abdomen is now of an irregular oblong shape, being contracted by the muscles of every segment, and is become one vast

matrix full of eggs, which make long circumvolutions through an innumerable quantity of very minute vessels that circulate round the inside in a serpentine manner, which would exercise the ingenuity of a skilful anatomist to dissect and develope. This singular matrix is not more remarkable for its amazing extension and size than for its peristaltic motion, which resembles the undulating of waves, and continues incessantly without any apparent effort of the animal; so that one part or other alternately is rising and sinking in perpetual succession, and the matrix seems never at rest, but is always protruding eggs to the amount (as I have frequently counted in old queens) of sixty in a minute, or eighty thousand and upwards in one day of twenty-four hours.

"These eggs are instantly taken from her body by her attendants (of whom there always are a sufficient number in waiting) and carried to the nurseries, which in a great nest may some of them be four or five feet distant in a straight line, and consequently much farther by their winding galleries. Here, after they are hatched, the young are attended and provided with every thing necessary until they are able to shift for themselves, and take their share of the labours of the community.

"The first object of admiration which strikes one, upon opening the hills or nests of the Termites, is the behaviour of the soldiers. If you make a breach in a slight part of the building, and do it quickly with a strong hoe or pickaxe, in the space of a few seconds a soldier will run out and walk about the breach, as if to see whether the enemy is gone, or to examine what is the cause of the attack. He will sometimes go in again, as if to give the alarm; but, most frequently, in a short time is followed by two or three others, who run as fast as they can, straggling after one another, and are soon followed by a large body who rush out as fast as the breach will permit them; and so they

proceed, the number increasing as long as any one continues battering their building. It is not easy to describe the rage and fury they show. In their hurry they frequently miss their hold, and tumble down the sides of the hill, but recover themselves as quickly as possible; and being blind, bite every thing they run against, and thus make a crackling noise, while some of them beat repeatedly with their forceps upon the building, and make a small vibrating noise, something shriller and quicker than the ticking of a watch. I could distinguish this noise at three or four feet distance, and it continued for a minute at a time, with short intervals. While the attack proceeds, they are in the most violent agitation. If they get hold of any one, they will in an instant let out blood enough to weigh against their whole body; and if it is the leg they wound, you will see the stain upon the stocking extend an inch in width. They make their hooked jaws meet at the first stroke, and never quit their hold, but suffer themselves to be pulled away leg by leg, and piece after piece, without the least attempt to escape. On the other hand, keep out of their way, and give them no interruption, and they will in less than half an hour retire into the nest, as if they supposed the wonderful monster that damaged their castle to be gone beyond their reach. Before they are all got in, you will see the labourers in motion, and hastening in various directions towards the breach; every one with a burthen of mortar in his mouth ready tempered. This they stick upon the breach as fast as they come up, and do it with so much dispatch and facility, that, although there are thousands, and I may say millions, of them, they never stop or embarrass one another; and you are most agreeably deceived when, after an apparent scene of hurry and confusion, a regular wall arises, gradually filling up the chasm. While they are thus employed, almost all the soldiers are retired quite out of sight, except here and there one, who

saunters about among six hundred or a thousand of the l bourers, but never touches the mortar either to lift or c ry it. One in particular places himself close to the w they are building. This soldier will turn himself leisure on all sides, and every now and then, at intervals of minute or two, lift up his head, and with his forceps be upon the building, and make the vibration noise befo mentioned: on which immediately a loud hiss, which a pears to come from all the labourers, issues from withinsi the dome and all the subterraneous caverns and passag That it does come from the labourers is very evident, you will see them all hasten at every such signal, redoub their pace, and work as fast again.

"We meet vast obstacles in examining the interior p of these tumuli. In the first place, the works, for instan the apartments which surround the royal chamber and nurseries, and indeed the whole internal fabric, are mo and consequently the clay is very brittle: they have so close a connexion, that they can only be seen as it we by piecemeal: for having a kind of geometrical depen ence or abutment against each other, the breaking of o arch pulls down two or three. To these obstacles must b added the obstinacy of the soldiers, who fight to the ve last, disputing every inch of ground so well as often to driv away the negroes who are without shoes, and make whit people bleed plentifully through their stockings. Neithe can we let a building stand so as to get a view of the in terior parts without interruption, for while the soldiers are defending the outworks, the labourers keep barricadoing all the way against us, stopping up the different galleries and passages which lead to the various apartments, partic ularly the royal chamber, all the entrances to which they fill up so artfully as not to let it be distinguishable while it remains moist: and externally it has no other appearance than that of a shapeless lump of clay. It is, however, easi ly found from its situation with respect to the other parts

of the building, and by the crowds of labourers and soldiers which surround it, who show their loyalty and fidelity by dying under its walls. The royal chamber in a large nest is capacious enough to hold many hundreds of the attendants besides the royal pair, and you always find it as full of them as it will hold. These faithful subjects never abandon their charge even in the last distress; for whenever I took out the royal chamber, and, as I often did, preserved it for some time in a large glass bowl, all the attendants continued running in one direction round the king and queen with the utmost solicitude, some of them stopping on every circuit at the head of the latter, as to give her something. When they came to the extremity of the abdomen, they took the eggs from her, and carried them away, and piled them carefully together in some part of the chamber, or in the bowl under, or behind any pieces of broken clay which would lie most convenient for the purpose.

"Some of these little unhappy creatures would ramble from the chamber, as if to explore the cause of such a horrid ruin and catastrophe to their immense building, as it must appear to them; and, after fruitless endeavours to get over the side of the bowl, return and mix with the crowd that continued running round their common parents to the last. Others, placing themselves along her side, get hold of the queen's vast matrix with their jaws, and pull with all their strength, so as visibly to lift up the part that they fix at; but, as I never saw any effect from these attempts, I never could determine whether this pulling was with an intention to remove her body, or to stimulate her to move herself, or any other purpose; but, after many ineffectual tugs, they would desist, and join in the crowd running round, or assist some of those who are cutting off clay from the external parts of the chamber, or some of the fragments, and moistening it with the juices of their bodies, to begin to work a thin arched shell over the body of the queen, as

if to exclude the air, or to hide her from the observation of some enemy. These, if not interrupted, before the next morning completely cover her, leaving room enough within for great numbers to run about her.

"I do not mention the KING in this case, becaus he is very small in proportion to the queen, not being bigger

than thirty of the labourers, so that he generally conceals himself under one side of the abdomen, except when he goes up to the queen's head, which he does now and then, but not so frequently as the rest.

"If in your attack on the hill you stop short of the royal chamber, and cut down about half of the building, and leave open some thousands of galleries and chambers, they will all be shut up with thin sheets of clay before the next morning. If even the whole is pulled down, and the different buildings are thrown in a confused heap of ruins, provided the king and queen are not destroyed or taken away, every interstice between the ruins, at which either cold or wet can possibly enter, will be so covered as to exclude both; and, if the animals are left undisturbed, in about a year they will raise the building to near its pristine size and grandeur.

"The Marching Termites are not less curious in their order, as far as I have had an opportunity of observing them, than those described before. This species seems much scarcer than the Termites bellicosi. I could get no information relative to them from the black people, from which I conjecture they are little known to them. My seeing them was very accidental. One day, having made

an excursion with my gun up the river Camerankoes, on my return through the thick forest, whilst I was sauntering very silently in hopes of finding some sport, on a sudden I heard a loud hiss, which, on the account of the many serpents in those countries, is a most alarming sound. The next step caused a repetition of the noise, which I soon recognized, and was rather surprised, seeing no covered ways or hills. The noise, however, led me a few paces from the path, where, to my great astonishment and pleasure, I saw an army of Termites coming out of a hole in the ground, which could not be above four or five inches wide. They came out in vast numbers, moving forward as fast seemingly as it was possible for them to march. In less than a yard from this place they divided into two streams or columns, composed chiefly of the first order, which I call labourers, twelve or fifteen abreast, and crowded as close after one another as sheep in a drove, going straight forward without deviating to the right or left. Among these, here and there, one of the soldiers was to be seen, trudging along with them in the same manner, neither stopping nor turning; and as he carried his enormous large head with apparent difficulty, he put me in mind of a very large ox amidst a flock of sheep. Whilst these were bustling along, a great many soldiers were to be seen spread about on both sides of the two lines of march, some a foot or two distant, standing still or sauntering about, as if upon the look out lest some enemy should suddenly come upon the labourers. But the most extraordinary part of this march was the conduct of some others of the soldiers, who, having mounted the plants which grow thinly here and there in the thick shade, had placed themselves upon the points of the leaves, which were elevated ten or fifteen inches above the ground, and hung over the army marching below. Every now and then one or other of

them beat with his forceps upon the leaf, and made th same sort of ticking noise which I had so frequently o served to be made by the soldier who acts the part of t surveyor or superintendent, when the labourers are at wo repairing a breach made in one of the common hills of t Termites bellicosi. This signal among the marchi White Ants produced a similar effect; for, wheneve was made, the whole army returned a hiss, and obeyed signal by increasing their pace with the utmost hurry. T soldiers who had mounted aloft, and gave their signals, quite still during these intervals (except making now then a slight turn of the head) and seemed as solicitou keep their posts as regular sentinels. The two column the army joined into one about twelve or fifteen paces f their separation, having in no part been above three y asunder, and then descended into the earth by two or t holes. They continued marching by me for above an that I stood admiring them, and seemed neither to crease nor diminish their numbers, the soldiers only cepted, who quitted the line of march, and placed th selves at different distances on each side of the two umns; for they appeared much more numerous befo quitted the spot. Not expecting to see any chang their march, and being pinched for time, the tide b nearly up, and our departure fixed at high water, I qu the scene with some regret, as the observation of a d two might have afforded me the opportunity of expl the reason and necessity of their marching with such pedition, as well as of discovering their chief settlemen which is probably built in the same manner as the larg hills before described.

"The economy of Nature is wonderfully displayed in comparative observation on the different species who a calculated to live under ground until they have wings, a

this species which marches in great bodies in open day. The former, in the two first states, that is, of labourers and soldiers, have no eyes that I could ever discover: but when they arrive at the winged or perfect state in which they are to appear abroad, though only for a few hours, and that chiefly in the night, they are furnished with two conspicuous and fine eyes: so the Termites viarum, or marching Bugga Bugs, being intended to walk in the open air and light, are even in the first state furnished with eyes proportionably as fine as those which are given to the winged or perfect insects of the other species."

THE SUGAR ANT

Is so called from the ruinous effect which it produces on the sugarcane. The mischief, however, is not done by the insect devouring the cane, but by its burrowing and forming lodgments under the roots. The Sugar Ant first made its appearance, about fifty years ago, on a plantation in Grenada, whence it rapidly spread on all sides. In the course of a few years it destroyed every plantation in a space of about twelve miles; and, as colonies of the destroyers began to appear in other parts, there was reason to fear that all the canes in the island would be annihilated at no distant period. A reward of twenty thousand pounds was offered by the legislature to whoever could accomplish the destruction of this formidable enemy. Poison and fire were among the means resorted to. But though myriads of myriads were thus killed, so prodigious was the number of the Sugar Ants that their hosts were not perceptibly thinned. For miles the roads were covered with them, and in many places the Ants were so thick that the print of the horses' feet would appear for a moment or two, till filled up by the progress of the surrounding multitudes. At length, when the planters began to des-

pair, they were freed from this calamity by the sudden violence of another. The tremendous hurricane of 1780, which twisted up the canes by the roots, laid bare the nests of the Ants, and the deluge of rain which accompanied it completed the destruction of the ravagers and of their progeny.

SOUTH AMERICAN ANTS.

The swarms of Ants which are found in South America are mentioned by that observant and veracious traveller Dampier. One species, the small yellow Ant, is so thick among the boughs in some places, that a person underneath is almost instantaneously covered with them. Their sting is like a spark of fire. Their winter nests, some of which are as big as a hogshead, are placed on great trees, between the body and the limbs.

"In the dry season (says he) when they leave their nests, they swarm all over the woodlands; for they never trouble the savannahs: great paths, three or four inches broad, made by them, may be seen in the woods. They go out light, but bring home heavy loads on their backs, all of the same substance and equal in size. I never observed any thing besides pieces of green leaves, so big that I could scarcely see the insect for his burthen; yet they would march stoutly, and so many were pressing forward, that it was a very pretty sight, for the path looked perfectly green with them.

"There was one sort of Ants of a black colour, tolerably large, with long legs. These would march in troops, as if they were busy in seeking somewhat: they were always in haste, and always followed their leaders, let them go where they would. They had no beaten path to walk in, but rambled about like hunters. Sometimes a band of these Ants would happen to march through our huts, over our

beds, or into our pavilions, nay, sometimes into our chests, and there ransack every part; and wherever the foremost went, the rest all came after. We never disturbed them, but gave them free liberty to search where they pleased; and they would all march off before night. They were so very numerous that they would sometimes be two or three hours in passing, though they went very fast."

NEW SOUTH WALES ANTS.

Of the Ants which are found in New South Wales three species were particularly observed by the men of science who accompanied Captain Cook.

"Some (says the writer) are as green as a leaf, and live upon trees, where they build their nests of various sizes, between that of a man's head and his fist. These nests are of a very curious structure: they are formed by bending down several of the leaves, each of which is as broad as a man's hand, and gluing the points of them together so as to form a purse. The viscous matter used for this purpose is an animal juice, which nature has enabled them to elaborate. Their method of first bending down the leaves we had no opportunity to observe; but we saw thousands uniting all their strength to hold them in this position, while other busy multitudes were employed within, in applying this gluten, that was to prevent their returning back. To satisfy ourselves that the leaves were bent and held down by the effort of these diminutive artificers, we disturbed them in their work; and as soon as they were driven from their station, the leaves on which they were employed sprang up with a force much greater than we could have thought them able to conquer by any combination of their strength. But, though we gratified our curiosity at their expense, the injury did not go unrevenged; for thousands immediately threw themselves up-

on us, and gave us intolerable pain with their stings, especially those which took possession of our necks and hair, from whence they were not easily driven. Their sting, was scarcely less painful than that of a bee: but, unless it was repeated, the pain did not last more than a minute.

"Another sort are quite black, and their operations and manner of life are not less extraordinary. Their habitations are the inside of the branches of a tree, which they contrive to excavate by working out the pith almost to the extremity of the slenderest twig; the tree at the same time flourishing, as if it had no such inmate. When we first found the tree, we gathered some of the branches, and were scarcely less astonished than we should have been to find that we had profaned a consecrated grove, where every tree upon being wounded gave signs of life; for we were instantly covered with legions of these animals, swarming from every broken bough, and inflicting their stings with incessant violence.

"A third kind we found nested in the root of a plant which grows on the bark of trees in the manner of misletoe, and which they had perforated for that use. This root is commonly as big as a large turnip, and sometimes much bigger. When we cut it, we found it intersected by innumerable winding passages, all filled with these animals, by which, however, the vegetation of the plant did not appear to have suffered any injury. We never cut one of these roots that was not inhabited, though some were not bigger than a hazel-nut. The animals themselves are red, and very small, not more than half as big as the common red Ant in England. They had stings, but scarcely force enough to make them felt: they had, however, a power of tormenting us in an equal if not in a greater degree; for the moment we handled the root, they swarmed

from innumerable holes; and, running about those parts of the body that were uncovered, produced a titillation more intolerable than pain, except it is increased to great violence.''

THE BEETLE.

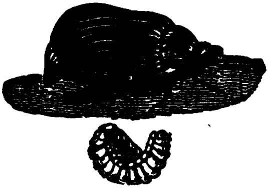
Of the Beetle there are various kinds; all, however, concurring in one common formation of having cases to their wings, which are the more necessary to those insects, as they often live under the surface of the earth, in holes which they dig out by their own industry. These cases prevent the various injuries their real wings might sustain by rubbing or crushing against the sides of their abode. These, though they do not assist in flight, yet keep the internal wings clean and even, and produce a loud buzzing noise when the animal rises in the air.

If we examine the formation of all animals of the Beetle kind, we shall find, as in shell fish, that their bones are placed externally, and their muscles within. These muscles are formed very much like those of quadrupeds, and are endued with such surprising strength that, bulk for bulk, they are a thousand times stronger than those of a man. The strength of these muscles is of use in digging the animal's subterraneous abode, where it is most usually hatched, and to which it most frequently returns, even after it becomes a winged insect capable of flying.

Besides the difference which results from the shape and colour of these animals, the size also makes a considerable one; some Beetles being not larger than the head of the pin, while others, such as the elephant Beetle, are as big as one's fist. But the greatest difference among them is, that some are produced in a month, and in a single season go through all the stages of their existence, while others take near four years to their produc-

tion; and live as winged insects a year more. To give the history of all these animals, that are bred pretty much in the same way, would be insipid and endless; it will suffice to select a few from the number, the origin of which may serve as specimens of the rest. We will therefore begin by offering the history of the May-bug to the reader's attention; premising, that most other Beetles, though not so long-lived, are bred in the same manner.

THE COCKCHAFER,



MAY-BUG, or Dor Beetle, as some call it, has, like all the rest, a pair of cases to its wings, which are of a reddish brown colour, sprinkled with a whitish dust, which easily comes off. In some years their necks are seen covered with a red plate, and in others with a black; these, however, are distinct sorts, and their difference is by no means accidental. The fore legs are very short, and the better calculated for burrowing in the ground, where this insect makes its retreat. It is well known to children by its evening buzz; but still more formidably introduced to the acquaintance of husbandmen and gardeners; for in some seasons it has been found to swarm in such numbers as to eat up every vegetable production.

The two sexes in the Cockchafer are easily distinguished from each other by the superior length of the tufts, at the end of the horns, in the male.

In about three months after the eggs have been deposit-

ed in the earth, the contained insect begins to break its shell, and a small grub or maggot crawls forth, and feeds upon the roots of whatever vegetable it happens to be nearest. All substances of this kind seem equally grateful; yet it is probable the mother insect has a choice among what kind of vegetables she shall deposit her young. In this manner these voracious creatures continue in the worm state for more than three years, devouring the roots of every plant they approach, and making their way under ground in quest of food with great despatch and facility. They thus become one of the greatest nuisances of the farmer; as, when numerous, they will destroy whole fields of grass. At length they grow to above the size of a walnut, being a great thick white maggot with a red head, which is seen most frequently in new turned earth, and which is so eagerly sought after by birds of every species.

When largest, they are found an inch and a half long, of a whitish yellow colour, with a body consisting of twelve segments or joints, on each side of which there are nine breathing holes, and three red feet. The head is large in proportion to the body, of a reddish colour, with a pincer before, and a semicircular lip, with which it cuts the roots of plants, and sucks out their moisture. As this insect lives entirely under ground, it has no occasion for eyes, and accordingly it is found to have none; but is furnished with two feelers, which, like the crutch of a blind man, serve to direct its motions. Such is the form of this animal, that lives for years in the worm state under ground, still voracious, and every year changing its skin.

It is not till the end of the fourth year that this extraordinary insect prepares to emerge from its subterraneous abode; and even this is not effected but by a tedious preparation.

About the latter end of autumn, the grub begins to perceive the approach of its transformation; it then buries itself deeper and deeper in the earth, sometimes six feet beneath the surface, and there forms itself a capacious apartment, the walls of which it renders very smooth and shining by the excretions of its body. Its abode being thus formed, it begins soon after to shorten itself, to swell, and to burst its last skin, in order to assume the form of a chrysalis. This in the beginning appears of a yellowish colour, which heightens by degrees, till at last it is seen nearly red. Its exterior form plainly discovers all the vestiges of the future winged insect, all the fore parts being distinctly seen; while behind, the animal seems as if wrapped in swaddling clothes.

The yonng Cockchafer continues in this state for about three months longer, and it is not till the beginning of January that the aurelia divests itself of all its impediments, and becomes a winged insect, completely formed. Yet still the animal is far from attaining its natural strength, health, and appetite. It undergoes a kind of infant imbecility; and unlike most other insects, that the instant they become flies are arrived at their state of full perfection, the Chafer continues feeble and sickly.

Its colour is much brighter than in the perfect animal; all its par s are soft, and its voracious nature seems, for a while, to have entirely forsaken it.

About the latter end of May, these insects, after having lived for four years under ground, burst from the earth, when the first mild evening invites them abroad. They are at that time seen rising from their long imprisonment, from living long only upon roots, and imbibing only the moisture of the earth, to visit the mildness of the summer air, to choose the sweetest vegetables for their banquet, and to drink the dew of the evening.

Wherever an attentive observer then walks abroad, he will see them bursting up before him in his pathway, like ghosts on a theatre. He will see every part of the earth, that had its surface beaten into hardness, perforated by their egression. When the season is favourable for them, they are seen by thousands, buzzing along, hitting against every object that intercepts their flight. The mid-day sun, however, seems too powerful for their constitutions; they then lurk under the leaves and branches of some shady tree; but the willow seems particularly their most favourite food: there they lurk in clusters, and seldom quit the tree till they have devoured all its verdure.

Their duration, however, is but short, as they never survive the season.

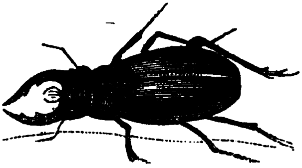
Of all the Beetle kind this is the most numerous, and therefore deserves the chief attention of history. Like them, all other Beetles are bred from the egg, which is deposited in the ground, or sometimes, though seldom, in the barks of trees; they change into a worm; they subsist in that state by living upon the roots of vegetables, or the succulent parts of the bark around them.

It would be endless to give a description of all, and yet it would be an unpardonable omission not to mention the particularities of some Beetles, which are singular either from their size, their manners, or their formation.

THE GREAT STAG BEETLE.

This insect, which is the largest that Great Britain produces, belongs, in the Linnæan classification, to the order Coleoptera. From the point of its jaws to the extremity of its abdomen, it sometimes measures three inches. It is of a dark brown colour, with the exception of the jaws, which are occasionally as red as coral. When this occurs

the animal has a very beautiful appearance. The Stag Beetle may easily be distinguished by these jaws, which



resemble the horns of a stag. In some districts of the south of England it is very common in oak and willow trees. It flies abroad, and feeds upon the leaves, only in the evening, and is principally seen in the month of July. The mandibles, those of the male in particular, are so strong that it can pinch with them severely. It is a popular belief in Germany that this insect carries burning coals into houses by means of its jaws, and that many dreadful fires have been caused by this singular propensity. On this subject, however, we may be allowed to be incredulous. One very curious circumstance respecting the Stag Beetle is an ascertained fact. Mr. Bingly frequently found several of their heads near together, and alive, while the trunks and abdomens were no where to be seen; and at other times only the abdomens were gone, and the heads and trunks were left. As the insect does not fly until the birds have retired to rest, it appears to be difficult to account for this. A friend of Mr. Bingley suggested that, as they are among the fiercest of the insect tribes, it might arise from their fighting with each other; but he confessed himself at a loss to discover what became of the abdomens. Indeed, his mode of explaining the matter strongly reminds us of the Irishman's story of two cats, which being shut up in a garret at night, fought and devoured each other; so that, in the morning, nothing was to be found of them but the tip of an ear and part of a tail.

That Beetle which the Americans call the TUMBLE-DUNG particularly demands our attention; it is all over of a dusky black, rounder than those animals are generally found to be, and so strong, though not much larger than the common black Beetle, that if one of them be put under a brass candlestick, it will cause it to move backwards and forwards, as if it were by an invisible hand, to the admiration of those who are not accustomed to the sight; but this strength is given it for much more useful purposes than those of exciting human curiosity, for there is no creature more laborious, either in seeking subsistence or in providing a proper retreat for its young. They are endowed with sagacity to discover subsistence by their excellent smelling, which directs them in flights to excrements just fallen from man or beast, on which they instantly drop, and fall unanimously to work in forming round balls or pellets thereof, in the middle of which they lay an egg. These pellets, in September, they convey three feet deep in the earth, where they lie till the approach of spring; when the eggs are hatched, the nest bursts, and the insects find their way out of the earth. They assist each other, with indefatigable industry, in rolling these globular pellets to the place where they are to be buried. This they perform, with the tail foremost, by raising up their hinder part, and shoving along the ball with their hind feet. They are always accompanied with other Beetles of a larger size, and of a more elegant structure and colour. The breast of this is covered with a shield of a crimson colour, and shining like metal; the head is of the like colour, mixed with green, and on the crown of the head stands a shining black horn, bended backwards. These are called the Kings of the Beetles; but for what reason is uncertain, since they partake of the same dirty drudgery with the rest.

The ELEPHANT BEETLE is the largest of this kind hitherto known, and is found in South America, particularly

Guiana and Surinam, as well as about the river Oroonoko. It is of a black colour, and the whole body is covered with a very hard shell, full as thick and as strong as that of a small crab. Its length, from the hinder part of the eyes, is almost four inches, and from the same part to the end of the proboscis, or trunk, four inches and three quarters. The transverse diameter of the body is two inches and a quarter, and the breadth of each elytron, or case for the wings, is an inch and three-tenths. The antennæ, or feelers, are quite horny; for which reason the proboscis, or trunk, is moveable at its insertion into the head, and seems to supply the place of feelers. The horns are eight-tenths of an inch long, and terminate in points. The proboscis is an inch and a quarter long, and turns upwards, making a crooked line, terminating in two horns, each of which is near a quarter of an inch long; but they are not perforated at the end like the proboscis of other insects. About four-tenths of an inch above the head, or that side next the body, is a prominence, or small horn, which, if the rest of the trunk were away, would cause this part to resemble the horn of a rhinoceros. There is indeed a Beetle so called, but then the horn or trunk has no fork at the end, though the lower horns resemble this. The feet are all forked at the end, but not like the lobster's claws.

THE GIGANTIC COCKROACH.

The above insect is the largest of its species, and is almost the size of a hen's egg. It is a native and plague of the warm parts of Asia, Africa, and South America. This, and indeed all the other species of Cockroaches, are a race of pestiferous beings, equally noisome and mischievous to natives or strangers. These filthy and voracious insects fly out in the evening, plunder and defile all kinds of victuals, dressed and undressed, and damage all sorts of

clothing, every thing made of leather, books, paper, and various other articles. They fly into the flame of candles,

and sometimes into the dishes; and they are very fond of ink and of oil, into which they are apt to fall and perish. In this case, they soon turn most offensively putrid, so that a man might as well sit over the putrid body of a large animal as write with the ink in which they have died. They often fly into the faces or bosoms of persons, and their legs being armed with sharp spines, the pricking excites a sudden horror not easily repressed. In old houses they swarm by myriads, making indescribably nasty every part where they harbour, which in the day time is in dark corners, behind all sorts of clothes, in trunks, boxes, and in short every place were they can lie concealed. In old timber and deal houses, when the family is retired at night to sleep, this insect, among its other disagreeable properties, has the power of making a noise which very much resembling a pretty smart knocking with the knuckle upon wainscoting: in the West Indies it is therefore frequently known by the name of the Drummer.

THE BURYING SYLPH, OR BURYING BEETLE.

Of this curious insect, which is a native of England, and of almost every part of Europe, the body and wing cases

are black; the latter have two ferruginous sinuate bands. The clubs of the antennæ are red. It derives its name

from its habit of burying in the ground the dead bodies of animals, in order to provide a proper nidus for its eggs, and to nourish the young family of grubs that proceeds from these eggs. In accomplishing this work, the strength and perseverance which it displays, and the rapidity with which it performs its labour, are truly astonishing. Mr. Gleditsch, to whom we are indebted for our knowledge of the habits and economy of these insects, took a glass vessel, and half filled it with moist earth. Into this he put four Beetles with their young ones, and they immediately concealed themselves. This glass, covered with a cloth, was placed on the open ground, and in the course of fifty days, the four Beetles interred the bodies of four frogs, three small birds, two grasshoppers, and one mole, besides the entrails of a fish, and two small pieces of the lungs of an ox. In another instance, a single Beetle was put into the glass with the body of a mole, more than thirty times its own weight and bulk. About seven in the morning, the Beetle had drawn the head of the mole below; and, in pushing the earth backward, had formed a tolerably high rampart round it. By four in the afternoon the interment was completed. The insects perform their work by hollowing out the earth from under the body; and then arranging a cavity of the proper size by pushing all around the body the earth which they remove. To succeed in these efforts they lean themselves strongly on the collars, and, bending down their heads,

force out the earth around the carcass. When the body has fallen into the hollow, they close it over.

THE DIAMOND BEETLE.

This Beetle belongs to the weevil tribe, and its scientific denomination is the Imperial Weevil. It inhabits South America, chiefly Brazil, and is the most resplendently coloured of all the insect class. The ground colour of the wings is a coal black, with numerous parallel lines of sparkling indentations round, which are of a green gold colour, highly brilliant, from minute reflecting scales, like the scales of a butterfly. There is another rich and elegant species of this insect in India; where, however, it is so very scarce, that the wing cases (and sometimes the whole insect), are set like a gem on rings, and worn by the great. The body is of a silky green with broad golden bands. This insect is the *Curculio regalis.*

THE GREAT WATER BEETLE.

This insect also bears the name of the Plunger, from the rapidity with which it dashes from the surface of the water to the bottom. At the bottom of the water, and even in the mud, it moves almost as vigorously as it does in plunging. It is a large Beetle, flattish and broad in proportion

to its length, and of a very compact form. Its colour is an olivaceous black, and it has a yellow margin round the thorax and exterior wing cases. From the prominent situ-

ation of its eyes, it can readily see in all directions. To catch it is a matter of difficulty, as it bites sharply. It is a wide devourer, preying not only on insects, but also on very young tadpoles, and the fry of fishes. When it is in the water it is kept constantly dry by a kind of oil or varnish, which repels the surrounding fluid. The larva is even more formidable and voracious than the full grown Beetle. The head is furnished with a very strong pair of forceps, which takes an exceedingly firm hold of any thing that it grasps. Whatever the larva can seize it eats; and as soon as it has dispatched one victim, it assails another.

To this class we may also refer the GLOW-WORM, that little animal which makes such a distinguished figure in the descriptions of our poets. No two insects can differ more than the male and the female of this species from each other. The male is in every respect a Beetle, having cases to its wings, and rising in the air at pleasure; the female, on the contrary, has none, but is entirely a creeping insect, and is obliged to wait the approaches of her capricious companion. The body of the female has eleven

joints, with a shield breastplate, the shape of which is oval; the head is placed over this, and is very small, and the three last joints of her body are of a yellowish colour; but what distinguishes it from all other animals, at least in this part of the world, is the shining light which it emits by night, and which is supposed by some philosophers to be an emanation which she sends forth to allure the male to her company.

Most travellers, who have gone through sandy countries, must well remember the little shining sparks with which the ditches are studded on each side of the road. If incited by curiosity to approach more nearly, he will find the light sent forth by the Glow-worm; if he should keep the little animal for some time, its light continues to grow paler, and at last appears totally extinct.

The CANTHARIS is of the Beetle kind, whence come cantharides, well known in the shops by the name of Spanish flies, and for their use in blisters. They have feelers like bristles, flexible cases to the wings, a breast pretty plain, and the sides of the belly wrinkled. Cantharides differ from each other in their size, shape, and colour; those used in the shops also do the same. The largest in these parts are about an inch long, and as much in circumference, but others are not above three quarters of an inch. Some are of a pure azure colour, others of pure gold, and others again have a mixture of pure gold and azure colours: but they are all very brilliant, and extremely beautiful. These insects, as is well known, are of the greatest benefit to mankind, making a part in various medicines conducive to human preservation. They are chiefly natives of Spain, Italy, and Portugal; but they are to be met also about Paris in the summer time, upon the leaves of the ash, the poplar, and the rose-trees, and also among wheat, and in meadows.

We are told, that the country people expect the retu of these insects every seven years. It is certain, th such a number of them have been seen together in the ai that they appeared like swarms of bees; and that th have so disagreeable a smell, that it may be perceive great way off, especially about sunset, though they a not seen at that time. This bad smell is a guide for tho who make it their business to catch them; when they a caught, they dry them: after which they are so light, th fifty will hardly weigh a dram. Those that gather the tie them in a bag, or a piece of linen cloth, that has be well worn, and then they kill them with the vapours of h vinegar, after which they dry them in the sun, and ke them in boxes.

An insect once supposed to be of great use in medici is that which is known by the name of the KERMES; it produced in the excrescence of an oak, called the ber bearing ilex, and appears at first wrapped up in a memb naceous bladder, of the size of a pea, smooth and shini of a brownish red colour, and covered with a very fine coloured powder. This bag teems with a number of re dish eggs, or insects, which being rubbed with the finge pour out a crimson liquor. It is only met with in wa countries, in the months of May and June.

In the month of April this insect becomes of the si and shape of a pea, and its eggs some time after bu from the womb, and soon, turning worms, run about th branches and leaves of the tree. They are of two sex and the females are those which we have been describin but the males are very distinct from the former, and are sort of small flies like gnats, with six feet, of which th four forward are short, and the two backward long, divid into four joints, and armed with three crooked nails. The

s two feelers on the head, a line and a half long, which moveable, streaked, and articulated. The tail, at the ck part of the body, is half a line long, and forked. The hole body is covered with two transparent wings, and ey leap about in the manner of fleas.

The harvest of the Kermes is greater or less in propor-n to the severity of the winter, and the women gather em before sunrising, tearing them off with their nails, for r there should be any loss from the hatching of the ects. They sprinkle them with vinegar, and lay them the sun to dry, where they acquire a red colour.

An insect still more useful than the former is the COCH-EAL.

This insect is of an oval form, of the size of a small pea, th six feet, and a snout or trunk. It brings forth its ung alive, and is nourished by sucking the juice of the nt. Its body consists of several rings; and when it is e fixed on the plant, it continues immoveable, being ject to no change. Some pretend there are two sorts, one domestic, which is best, and the other wild, that of a vivid colour; however, they appear to be the same; th only this difference, that the wild feed upon uncultiated trees, without any assistance; whereas, the domes-c is carefully, at a stated season, removed to cultivated ees, where it feeds upon a purer juice. Those who take re of these insects, place them on the prickly pear-plant, a certain order, and are very industrious in defending em from other insects; for if any other kind comes ong them, they take care to brush them off with foxes' ils. Towards the end of the year, when the rains and ld weather are coming on, which are fatal to these in-cts, they take off the leaves or branches, covered with e Cochineal that have not attained their utmost degree f perfection, and keep them in their houses till winter is

past. These leaves are very thick and juicy, and sup them with nourishment while they remain within doo When the milder weather returns, and these animals about to exclude their young, the natives make them ne like those of birds, but less, of tree-moss, or soft hay, or down of cocoa-nuts, placing twelve in every nest. Th they fix on the thorns of the prickly pear-plant, and three or four days' time they bring forth their you which leave their nests in a few days, and creep upon branches of the plant, till they find a proper place to rest

When the native Americans have gathered the Co ineal, they put them into holes in the ground, where t kill them with boiling water, and afterwards dry them the sun, or in an oven, or lay them upon hot plates. Fr the various methods of killing them, arise the different c ours which they appear in when brought to us. Wh they are living, they seem to be sprinkled over wit white powder, which they lose as soon as the boil water is poured upon them. Those that are dried u hot plates are the blackest. What we call the Cochin are only the females, for the males are a sort of fly, already observed in the kermes. They are used both dyeing and medicine, and are said to have much the sa virtue as the kermes, though they are now seldom u alone, but are mixed with other things for the sake of colour.

We shall end this account of the Beetle tribe, with history of an animal which cannot properly be ran under this species, and yet which cannot be more meth ically ranged under any other. This is the insect t forms and resides in the gall nut, the spoils of which converted to such useful purposes.

The Gall Insects are bred in a sort of bodies adher to a kind of oak in Asia, which differ with regard to th

colour, size, roughness, smoothness, and shape, and which we call Galls. They are not fruit as some have imagined, but preternatural tumours, owing to the wounds given to the buds, leaves, and twigs of the tree, by a kind of insect that lays its eggs within them. This animal is furnished with an implement, by which the female penetrates into the bark of the tree, or into that spot which just begins to bud, and there sheds a drop of corrosive fluid into the cavity. Having thus formed a receptacle for her eggs, she deposits them in the place, and dies soon after.

The juice or sap of the plant, thus turned back from its natural course, extravasates and flows round the egg; after which it swells and dilates by the assistance of some bubbles of air, which get admission through the pores of the bark, and which run in the vessels with the sap.

This little ball receives its nutriment, growth, and vegetation, as the other parts of the tree, by slow degrees, and is what we call the gall-nut. The worm that is hatched under this spacious vault, finds in the substance of the ball, which as yet is very tender, a subsistence suitable to its nature; gnaws and digests it till the time comes for its transformation to a nymph, or chrysalis, and from that state of existence changes into a fly. After this the insect, perceiving itself duly provided with all things requisite, disengages itself soon from its confinement, and takes its flight into the open air. The case, however, is not similar with respect to the gall-nut that grows in autumn. The cold weather frequently comes on before the worm is transformed into a fly, or before the fly can pierce through its enclosure. The nut falls with the leaves, and although you may imagine that the fly which lies within is lost, yet in reality it is not so; on the contrary, its being covered up so close is the means of its preservation. Thus it spends the winter in a warm house, where every crack and cranny of

the nut is well stopped up; and lies buried, as it were, under a heap of leaves, which preserves it from the injuries of the weather. This apartment, however, though so commodious a retreat in the winter, is a perfect prison in the spring. The fly, roused out of its lethargy by the first heats, breaks its way through, and ranges where it pleases. A very small aperture is sufficient, since at this time the fly is but a diminutive creature. Besides, the ringlets whereof its body is composed, dilate, and become pliant in the passage.

THE GNAT AND THE TIPULA.

There are two insects which entirely resemble each other in their form, and yet widely differ in their habits, manners and propagation. Those who have seen the Tipula, or Long-legs, and the larger kind of Gnat, have most probably mistaken the one for the other; they have often accused the Tipula, a harmless insect, of depredations made by the Gnat, and the innocent has suffered for the guilty.

The chief and only difference between them is, that the Tipula wants a trunk, while the Gnat has a large one, which it often exerts to very mischievous purposes.

The Gnat proceeds from a little worm, which is usually seen at the bottom of standing waters. The manner in which the insect lays its eggs is particularly curious; after having laid the proper number on the surface of the water, it surrounds them with a kind of unctuous matter, which prevents them from sinking; but at the same time fastens them with a thread to the bottom, to prevent their floating away at the mercy of every breeze, from a place the warmth of which is proper for their production, to another, where the water may be too cold, or its enemies too

numerous. Thus the insects in their egg state resemble a buoy, which is fixed by an anchor. As they come to maturity, they sink deeper, and at last, when they leave the eggs as worms, they creep at the bottom. They now make themselves lodgements of cement, which they fasten to some solid body at the very bottom of the water, unless by accident they meet a piece of chalk, which, being of a soft and pliant nature, gives them an opportunity of sinking a retreat for themselves, where nothing but the claws of a crayfish can possibly molest them. The worm afterwards changes its form. She appears with a large head, and a tail invested with hair, and moistened with an oleaginous liquor, which she makes use of as a cork to sustain her head in the hair, and her tail in the water, and to transport her from one place to another. When the oil with which her tail is moistened begins to grow dry, she discharges out of her mouth an unctuous humour which she sheds all over her tail, by virtue whereof she is enabled to transport herself where she pleases, without being either wet, or anywise incommoded by the water.

The Gnat in her second state is, properly speaking, in the form of a nymph, which is an introduction or entrance into a new life. In the first place, she divests herself of her second skin; in the next, she resigns her eyes, her antennæ, and her tail; in short, she actually seems to expire. However, from the spoils of the amphibious animal, a little winged insect cuts the air, whose every part is active to the last degree, and whose whole structure is the just object of our admiration. Its little head is adorned with a plume of feathers, and its whole body invested with scales and hair, to secure it from any wet or dust. She makes trial of the activity of her wings, by rubbing them either against her body, or her broad side-bags, which keep her in an equilibrium. The furbelow, or little

The Sheep Gad-fly is spotted with white and black on the abdomen; the head is white and punctured; the eyes are marbled; and the wings are pellucid, and punctured at the base. It deposits its eggs in the nostrils of the sheep. "The moment the flies touch the noses of the sheep, the animals shake their heads, and strike the ground with their fore feet; at the same time holding their noses to the earth; they run away, looking about them on every side, to see if the flies pursue. They also appear to smell the grass as they go, lest the insects should be lying in wait for them. If they observe one, they gallop back, or take some other direction. As they cannot, like cattle, take refuge in the water, they have recourse to a rut, or a dry dusty road, where they crowd together during the heat of the day, with their noses held close to the ground."

Of the Rein-deer Gad-fly there are two varieties. The one of these deposits its eggs on the back of the rein-deer, and is often fatal to that animal. "In Lapland," says Linnæus, "there is a fly covered with downy hair; it hovers all day over the rein-deer; their legs tremble under them; they prick up their ears, and flee to the mountains covered with snow and ice; with so much horror do they avoid so minute an insect hovering in the air." The other species lodges near the gullet of the deer, and there the larvæ take up their abode in families consisting of one hundred or more individuals.

The Human Gad-fly is a native of South America. It is about the size of a common house-fly, and its body is entirely brown. It inserts its egg under the skin of the abdomen, where it forms a swelling, in which the grub remains for six months. If the grub be molested, it keeps sinking deeper and deeper, and thus creates ulcers or inflammation, terminating in death.

THE WALKING LEAF.

This is a most remarkable insect, and is found in China. Its head is placed on a neck longer than the body itself, and is shaped like an awl, with two polished eyes, and two feelers. The wings are transparent.

This insect is generally of a beautiful green colour, which soon fades, and resembles a dead leaf; this causes the inhabitants to give it the name of the walking leaf.

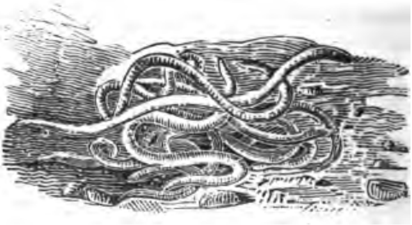
CHAP. XVI.

Of Zoophytes in general...Worms...*The Earth-worm*...*The Sea Worm*...*The White Water Worm*...*The* Star Fish...*The Cuttle Fish*...*The* Polypus...Lithophytes...*Different Species of Corals*...*Corallines*...*Sponges, &c.*

We are now come to the last link in the chain of animated nature, to a class of beings so confined in their powers, and so defective in their formation, that some historians have been at a loss whether to consider them as a superior rank of vegetables, or the humblest order of the animated tribe.

In the class of Zoophytes, we may place all those animals, which may be propagated by cuttings, or, in other words, which, if divided into two or more parts, each part in time becomes a separate and perfect animal; the head

shoots forth a tail, and, on the contrary, the tail pro head; some of these will bear dividing but into tw such is the earth-worm; some may be divided into m two, and of this kind are many of the star-fish; ot may be cut into a thousand parts, each becoming a animal; they may be turned inside out, like the a glove, they may be moulded into all manner of yet still their vital principle remains, still every si becomes perfect in its kind, and, after a few day ence, exhibits all the arts and industry of its parent shall therefore divide Zoophytes according to their degrees of perfection, namely into worms, star-fis polypi; contenting ourselves with a short review o creatures, that excite our curiosity chiefly by their fections.



The first in the class of Zoophytes are animals of t Worm kind, which, being entirely destitute of feet, tr themselves along upon the ground, and find themselv a retreat under the earth, or in the water. As these, li serpents, have a creeping motion, so both, in general, under the common appellation of reptiles; a loathsom noxious, malignant tribe, to which man by nature has t strongest antipathy. But though worms, as well as se pents, are mostly without feet, and have been doomed creep along the earth on their bellies, yet their motio are very different. The serpent, as has been said befo

having a back bone, which it is incapable of contracting, bends its body into the form of a bow, and then shoots forward from the tail; but it is very different with the Worm, which has has a power of contracting or lengthening itself at will. There is a spiral muscle, that runs round its whole body, from the head to the tail, somewhat resembling a wire wound round a walking-cane, which, when slipped off, and one end extended and held fast, will bring the other nearer to it; in this manner the Earth-worm, having shot out or extended its body, takes hold by the slime of the fore part of its body, and so contracts and brings forward the hinder part: in this manner it moves onward, not without great effort; but the occasions for its progressive motion are few.

As it is designed for living under the earth, and leading a life of obscurity, so it seems tolerably adapted to its situation. Its body is armed with small stiff sharp burrs or prickles, which it can erect or depress at pleasure; under the skin there lies a slimy juice, to be ejected as occasion requires at certain perforations, between the rings of the muscles, to lubricate its body, and facilitate its passage into the earth. Like most other insects, it has breathing holes along the back, adjoining each ring; but it is without bones, without eyes, without ears, and, properly, without feet. It has a mouth, and also an alimentary canal, which runs along to the very point of the tail. In some Worms, however, particularly such as are found in the bodies of animals, this canal opens towards the middle of the belly, at some distance from the tail. The intestines of the Earth-worm are always found filled with a very fine earth, which seems to be the only nourishment these animals are capable of receiving.

The animal is entirely without brain, but near the head is placed the heart, which is seen to beat with a very dis-

and all the zoophyte tribe, continue to live in separate parts, and one animal, by the means of cutting, is divided into two distinct existences, sometimes into a thousand.

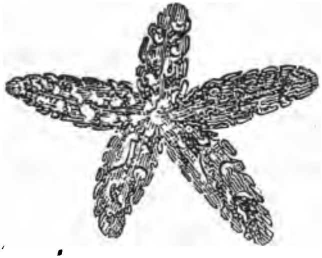
Spallanzani has tried several experiments upon the Earth-worm, many of which succeeded according to his expectation; every earth-worm, however, did not retain the vivacious principle with the same obstinacy; some, when cut in two, were entirely destroyed; others survived only in the nobler part; and, while the head was living, the tail entirely perished, and a new one was seen to burgeon from the extremity. But, what was most surprising of all, in some, particularly in the small red-headed Earth-worm, both extremities survived the operation; the head produced a tail, with the anus, the intestines, the annular muscle, and the prickly beards; the tail part, on the other hand, was seen to shoot forth the nobler organs, and in less than the space of three months sent forth a head, and a heart, with all the apparatus and instruments of generation. This part, as may be easily supposed, was produced much more slowly than the former, a new head taking above three or four months for its completion, a new tail being shot forth in less than as many weeks. Thus two animals by dissection were made out of one, each with their separate appetites, each endued with life and motion, and seemingly as perfect as that single animal whence they derived their origin.

What was performed upon the Earth-worm was found to obtain also in many other of the vermicular species.

The Sea Worm or Lug Worm, the White Water Worm, and many of those little Worms with feelers, found at the bottom of dirty ditches; in all these the nobler organs are of such little use, that if taken away, the animal does not seem to feel the want of them; it lives in all its

parts, and in every part; and, by a strange paradox in nature, the most useless and contemptible life is, of all others, the most difficult to destroy.

The next genus of zoophytes is that of the STAR-FISH, a numerous tribe, shapeless and deformed, assuming at different times different appearances. The same animal that now appears round like a ball, shortly after flattens as thin as a plate. They inhabit the sea, and are generally found on the sand, or among rocks, considerably below low water mark. They are covered with a coriaceous crust, and have five or more rays proceeding from a centre, in which is situated the mouth. A prodigious number of tentacula, or short fleshy tubes, which seem at once calculated to catch prey and to anchor the animal to the rocks, proceed from each ray. The mouth is armed with long teeth, for the purpose of breaking the shells on which the animals feed. The animal breathes by means of gills. The COMMON, or FIVE-RAYED STAR-FISH, which is the



species here represented, has five angular rays, with prickly protuberances at the angles. When alive it is usually of a brownish white colour. In one of these, which he kept for some time alive, Mr. Bingley observed more than four thousand tentacula, on the under sides of the rays.

In summer, when the water of the sea is warmed by the

heat of the sun, they float upon the surface, and in the dark they send forth a kind of shining light, resembling that of phosphorus.

They are often seen fastened to the rocks and to the largest sea shells, as if to derive their nourishment from them. If they be taken and put into spirit of wine, they will continue for many years entire; but if they be left to the influence of the air, they are, in less than four and twenty hours, melted down into limpid and offensive water.

In all of this species, none are found to possess a vent for their excrements, but the same passage by which they devour their food serves for the ejection of their fœces. These animals, as was said, take such a variety of figures, that it is impossible to describe them under one determinate shape; but, in general, their bodies resemble a truncated cone, whose base is applied to the rock to which they are found usually attached. Though generally transparent, yet they are found of different colours, some inclining to green, some to red, some to white, and some to brown. In some, their colours appear diffused over the whole surface; in some, they are streaked, and in others often spotted. They are possessed of a very slow progressive motion, and, in fine weather, they are continually seen stretching out and fishing for their prey. Of this tribe, the number is various, and the description of each would be tedious and uninstructive; the manners and nature of all are nearly as described; but we will just make mention of one creature, which, though not properly belonging to this class, yet is so nearly related, that the passing it in silence would be an unpardonable omission.

Of all animals, the Cuttle-Fish, though in some respects superior to this tribe, possesses qualities the most extraordinary.

THE GREAT CUTTLE-FISH.

This singular creature, which is about two feet long, has eight arms or claws, furnished on the interior side with little round serrated cups, by the contraction of which the animal lays fast hold of any thing that comes in its way. Besides these eight arms, it has two tentacula, four times longer than the preceding, and also pedunculated. When the suckers adhere to any thing, it is very difficult to loosen their hold. The mouth is situated in the centre, and is horny, and hooked like the bill of a parrot. It is so strong that the animal can break to pieces the shells of limpets and of other marine testaceous creatures on which it feeds. The eyes are below, and surrounded with several silvery rings; they are as large as the eyes of a calf, but are very prominent, and rather resemble the eyes of a crab. The body is of a reddish brown colour, nearly cylindrical. The belly below is equal, soft, smooth, oblong-round, of an ash and faintly yellowish colour: about the middle of the upper part of the body there is a fin like those of fishes, composed of a softish cartilaginous substance, spread out widely on both sides, and decreasing towards the tail till it ends in a point, like the broad fins of the ray-fish: by means of this fin it moves itself in swimming, having no

other membrane for that purpose. From this pointed termination of the tail, the French call it the Sea-spider, although it has scarcely any resemblance to the spider; but rather, with respect to the head, approaches to the shape of the star-fish. At any rate, they are very formidable animals. With their arms and trunks they fasten themselves, to resist the motion of the waves. The females lay their eggs upon seaweed and plants, in clusters like bunches of grapes. Immediately after they are laid they are white, and the males pass over and impregnate them with a black liquor, after which they grow larger and resemble black grapes. On opening one of the eggs, the embryo Cuttle is found alive. The noise of a Cuttle-fish, on being dragged out of the water, resembles the grunting of a boar. When the male is pursued by a sea-wolf or other ravenous fish, he shuns the danger by stratagem. He squirts out a black liquor, by which the water becomes as black as ink, and under shelter of this he baffles the pursuit of his enemy. This black liquor is elaborated in a particular gland. The Romans used it as ink; and it is said to be an ingredient in the composition of Indian ink. There is a bone in this animal which is converted into that useful article of stationary called pounce, and is also used by silversmiths to form moulds. This fish was much esteemed by the ancients, and is still eaten in the hot countries bordering on the Mediterranean.

In hot climates these creatures are found of an enormous size. The Indians affirm, that some have been seen two fathoms broad over their centre, and each arm nine fathoms long. This species is the Eight-armed Cuttle-fish, which has not the two tentacula possessed by the great or Officinal Cuttle-fish. When the Indians navigate their little boats, they go in dread of them; and, lest these animals should fling their arms over and draw them under

water, they never fail having an adze to cut them off. When used for food, they are served up in their own liquor, which from boiling, with the addition of nitre, becomes red. If taken into a dark apartment and cut open, it illuminates the whole place.

THE POLYPUS.

The common Polypus is found at the bottom of wet ditches, or attached to the under surface of the broad-leafed plants that grow and swim on the waters. The same difference holds between these and the sea-water Polypus, as between all the productions of the sea, and of the land and the ocean. The marine vegetables and animals grow to a monstrous size. The eel, the pike, or the bream, of fresh waters, is but small; but in the sea, they grow to an enormous magnitude. The herbs of the field are at most but a few feet high; those of the sea often shoot forth a stalk of a hundred. It is so between the Polypi of both elements. Those of the sea are found from two feet in length to three or four; and Pliny has even described one, the arms of which were no less than thirty feet long. Those in fresh waters, however, are comparatively minute; at their utmost size, seldom above three parts of an inch long; and, when gathered up into their usual form, not above a third even of those dimensions.

It was upon these minute animals that the power of dissection was first tried in multiplying their numbers. They had been long considered as little worthy the attention of observers, and were consigned to that neglect in which thousands of minute species of insects remain to this very day. It is true, indeed, that Reaumur observed, classed, and named them. By contemplating their motions, he was enabled distinctly to pronounce on their being of the animal and not of the vegetable kingdom; and he called them

Polypi, from their great resemblance to those larger ones th were found in the ocean. Still, however, their properti were neglected, and their history unknown.

Mr. Trembley is the person to whom we owe the fir discovery of the amazing properties and powers of this li tle vivacious creature: he divided this class of animals in four different kinds; into those inclining to green, tho of a brownish cast, those of flesh colour, and those whi he calls the Polype de panache. The difference of stru ture in these, as also of colour, are observable enough but the manner of their subsisting, of seizing their pre and of their propagation, is pretty nearly the same in all.

Whoever has looked with care into the bottom of a we ditch, when the water is stagnant, and the sun has bee powerful, may remember to have seen many little transpa rent lumps of jelly, about the size of a pea, and flatted o one side; such also as have examined the under side of th broad-leafed weeds that grow on the surface of the water must have observed them studded with a number of these little jelly-like substances, which were probably then dis regarded, because their nature and history were unknown. These little substances, however, were no other than living Polypi gathered up into a quiescent state, and seemingly inanimate, because either undisturbed, or not excited by the calls of appetite to action. When they are seen ex- erting themselves, they put on a very different appearance from that which they have when at rest; to conceive a just idea of their figure, we may suppose the finger of a glove cut off at the bottom; we may suppose also several threads or horns planted round the edge like a fringe. The hollow of this finger will give us an idea of the stomach of the animal; the threads issuing forth from the edges may be considered as the arms or feelers, with which it hunts for its prey. The animal, at its greatest extent, is

seldom seen above an inch and a half long, but it is much shorter when it is contracted and at rest; it is furnished neither with muscles nor rings, and its manner of lengthening or contracting itself more resembles that of the snail than worms, or any other insect. The Polypus contracts itself more or less, in proportion as it is touched, or as the water is agitated in which they are seen. Warmth animates them, and cold benumbs them; but it requires a degree of cold approaching congelation, before they are reduced to perfect inactivity; those of an inch have generally their arms double, often thrice as long as their bodies. The arms, where the animal is not disturbed, and the season not unfavourable, are thrown about in various directions, in order to seize and entangle its prey; sometimes three or four of the arms are thus employed, while the rest are contracted like the horns of a snail, within the animal's body. It seems capable of giving what length it pleases to these arms; it contracts and extends them at pleasure, and stretches them only in proportion to the remoteness of the object it would seize.

These animals have a progressive motion, which is performed by the power they have of lengthening and contracting themselves at pleasure; they go from one part of the bottom to another; they mount along the margin of the water, and climb up the side of aquatic plants. They often are seen to come to the surface of the water, where they suspend themselves by their lower end. As they advance but very slowly, they employ a great deal of time in every action, and bind themselves very strongly to whatever body they chance to move upon as they proceed; their adhesion is voluntary, and is probably performed in the manner of a cupping-glass applied to the body.

All animals of this kind have a remarkable propensity to turn towards the light, and this naturally might induce an

inquirer to look for their eyes; but however carefully this search has been pursued, and however excellent the microscope with which every part was examined, yet nothing of the appearance of this organ was found over the whole body; and it is most probable that, like several other insects, which hunt their prey by their feeling, these creatures are unfurnished with advantages which would be totally useless for their support.

In the centre of the arms, it was said before, the mouth is placed, which the animal can open and shut at pleasure, and this serves at once as a passage for food, and an opening for it after digestion. The inward part of the animal's body seems to be one great stomach, which is open at both ends; but the purposes which the opening at the bottom serves are hitherto unknown, but certainly not for excluding their excrements, for these are ejected at the aperture by which they are taken in. If the surface of the body of this little creature be examined with a microscope, it will be found studded with a number of warts, as also the arms, especially when they are contracted; and these tubercles, as we shall presently see, answer a very important purpose.

If we examine their way of living, we shall find these insects chiefly subsisting upon others much less than themselves; particularly a kind of millepedes that live in the water, and a very small red worm, which they seize with great avidity. In short, no insect whatsoever, less than themselves, seems to come amiss to them: their arms, as was observed above, serve them as a net would a fisherman, or perhaps, more exactly speaking, as a lime-tree does a fowler. Whenever their prey is perceived, which the animal effects by its feeling, it is sufficient to touch the object it would seize upon, and it is fastened without the power of escaping. The instant one of this insect's

long arms is laid upon a millepede, the little insect sticks without a possibility of retreating. The greater the distance at which it is touched, the greater is the ease with which the Polypus brings the prey to its mouth. If the little object be near, though irretrievably caught, it is not without great difficulty that it can be brought to the mouth and swallowed. When the Polypus is unsupplied with prey, it testifies its hunger by opening its mouth; the aperture, however, is so small that it cannot be easily perceived; but when, with any of its long arms, it has seized upon its prey, it then opens its mouth distinctly enough, and this opening is always in proportion to the size of the animal which it would swallow; the lips dilate insensibly by small degrees, and adjust themselves precisely to the figure of their prey. Mr. Trembley, who took a pleasure in feeding this useless brood, found that they could devour aliments of every kind, fish and flesh as well as insects; but he owns they did not thrive so well upon beef and veal, as upon the little worms of their own providing. When he gave one of these famished reptiles any substance which was improper to serve for aliment, at first it seized the prey with avidity, but, after keeping it for some time entangled near the mouth, let it drop again with distinguished nicety.

When several Polypi happen to fall upon the same worm, they dispute their common prey with each other. Two of them are often seen seizing the same worm at different ends, and dragging it in opposite directions with great force. It often happens that while one is swallowing its respective end, the other is also employed in the same manner, and thus they continue swallowing each his part, until their mouths meet together; they then each rest for some time in this situation, till the worm breaks between them, and each goes off with his share; but it often hap-

pens that a seemingly more dangerous combat ensues, when the mouths of both are thus joined upon one common prey together: the largest Polypus then gapes, and swallows his antagonist; but, what is very wonderful, the animal thus swallowed seems to be rather a gainer by the misfortune. After it has lain in the conqueror's body for about an hour, it issues unhurt, and often in possession of the prey which had been the original cause of contention: how happy would it be for men, if they had as little to fear from each other!

These reptiles continue eating the whole year, except when the cold approaches to congelation; and then, like most others of the insect tribe, they feel the general torpor of nature, and all their faculties are for two or three months suspended; but if they abstain at one time, they are equally voracious at another; and, like snakes, ants, and other animals that are torpid in the winter, the meal of one day suffices them for several months together. In general, however, they devour more largely in proportion to their size, and their growth is quick according as they are fed; such as are best supplied soonest acquire their largest size; but they diminish also in their growth with the same facility, if their food be taken away.

Such are the more obvious properties of these little animals, but the most wonderful still remain behind. Their manner of propagation, or rather multiplication, has for some years been the astonishment of all the learned of Europe. They are produced in as great a variety of manner as the different species of vegetables. Some Polypi are propagated from eggs, as plants are from their seed; some are produced by buds issuing from their bodies, while all may be multiplied by cuttings, and this to a degree of minuteness that exceeds even philosophical perseverance.

With respect to such of this kind as are hatched from the

egg, little that is curious can be added; but with regard to such as are produced like buds from their parent stem, or like cuttings from an original root, their history requires a more detailed explanation. If a Polypus be carefully observed in summer, when these animals are chiefly active, and more particularly prepared for propagation, it will be found to send forth, from different parts of its body, several tubercles, or little knobs, which grow larger and larger every day; after two or three days inspection, what at first appeared but a small excrescence, takes the figure of small animal, entirely resembling its parent, furnished with feelers, a mouth, and all the apparatus for seizing and digesting its prey. This little creature every day becomes larger, like the parent, to which it continues attached; it spreads its arms to seize upon whatever insect is proper for aliment, and devours it for its own particular benefit; thus it is possessed of two sources of nourishment, that which it receives from the parent by the tail, and that which it receives from its own industry by the mouth. The food which these animals receive often tinctures the whole body; and upon this occasion the parent is often seen communicating a part of its own fluids to that of its progeny that grows upon it; while on the contrary, it never receives any tincture from any substance that is caught and swallowed by its young. If the parent swallows a red worm, which gives a tincture to all its fluids, the young one partakes of the paternal colour; but if the latter should seize upon the same prey, the parent Polypus is no way benefited by the capture, but all the advantage remains with the young one.

But we are not to suppose that the parent is capable of producing only one at a time; several young ones are thus seen at once, of different sizes, growing from its body; some just budding forth, others acquiring their perfect

form, and others come to sufficient maturity, and just ready to drop from the original stem, to which they had been attached for several days. But what is more extraordinary still, those young ones themselves that continue attached to their parent, are seen to burgeon and propagate their own young ones also, each holding the same dependence upon its respective parent, and possessed of the same advantages that have been already described in the first connexion.

This seems to be the most natural way by which these insects are multiplied; their production from the egg being not so common; and though some of this kind are found with a little bladder attached to their bodies, which is supposed to be filled with eggs, which afterwards come to maturity, yet the artificial method of propagating these animals is much more expeditious, and equally certain: it is indifferent whether one of them be cut into ten, or ten hundred parts; each becomes as perfect an animal as that which was originally divided; but it must be observed, that the smaller the part which is thus separated from the rest, the longer it will be in coming to maturity, or in assuming its perfect form. M. Trembley ascertained that various portions of one Polypus can be engrafted on another of a different species, and he thus formed some of the most singular combinations that can well be imagined.

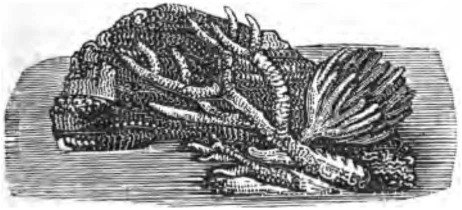
Besides these kinds mentioned by Mr. Trembley, there are various others, which have been lately discovered by the vigilance of succeeding observers, and some of these so strongly resemble a flowering vegetable in their forms, that they have been mistaken by many naturalists for such.

Mr. Hughes, the author of the Natural History of Barbadoes, has described a species of this animal, but has mistaken its nature, and called it a sensitive flowering plant;

he observed it to take refuge in the holes of rocks, and, when undisturbed, to spread forth a number of ramifications, each terminated by a flowery petal, which shrunk at the approach of the hand, and withdrew into the hole, whence before it had been seen to issue. This plant, however, was no other than an animal of the Polypus kind, which is not only to be found in Barbadoes, but also on many parts of the coast of Cornwall, and along the shores of the continent.

LYTHOPHYTES AND SPONGES.

If we examine the bottom of the sea, along some shores, and particularly at the mouths of several rivers, we shall find it has the appearance of a forest of trees under water, millions of plants growing in various directions, with their branches entangled in each other, and sometimes standing so thick as to obstruct navigation. The shores of the Persian Gulf, the whole extent of the Red Sea, and the western coasts of America, are so choked up in many places with these Coralline substances, that though ships force a passage through them, boats and swimmers find it impossible to make their way. These aquatic groves are formed of different substances, and assume various appearances.



The Coral plants, as they are called, sometimes shoot out, like trees without leaves in winter; they often spread out a broad surface like a fan, and not uncommonly a large

bundling head, like a faggot; sometimes they are found to resemble a plant with leaves and flowers, and often the antlers of a stag, with great exactness and regularity. In other parts of the sea are seen Sponges, of various magnitude, and extraordinary appearances, assuming a variety of fantastic forms, like large mushrooms, mitres, fonts, and flowerpots. An immense Coral reef extends for several hundred miles along the coast of New Holland, and innumerable islands and reefs are formed in the South Seas.

If in our researches after the nature of these plants, we should be induced to break off a branch of the Coralline substance, and observe it carefully, we shall perceive its whole surface, which is very rugged and irregular, covered with a mucous fluid, and almost in every part studded with little jellylike drops, which, when closely examined, will be found to be no other than insects of the polypus kind. These have their motions, their arms, their appetites, exactly resembling those described in this chapter; but they soon expire when taken out of the sea, and our curiosity is at once stopped in its career, by the animals ceasing to give any instance of their industry; recourse, therefore, has been had to other expedients, in order to determine the nature of the inhabitant, as well as the habitation.

If a Coralline plant be strictly observed while still growing in the sea, and the animals upon its surface be not disturbed, either by the agitation of the waters, or the touch of the observer, the little polypi will then be seen in infinite numbers, each issuing from its cell, and in some kinds the head covered with a little shell, resembling an umbrella, the arms spread abroad, in order to seize its prey, while the hinder part still remains attached to its habitation, whence it never wholly removes. By this time it is perceived that the number of inhabitants is infinitely greater than was at first suspected; that they are all assiduous

employed in the same pursuits, and that they issue from their respective cells, and retire into them at pleasure. Still, however, there are no proofs that those large branches which they inhabit are entirely the construction of such feeble and minute animals. But chemistry will be found to lend a clue to extricate us from our doubts in this particular. Like the shells which are formed by snails, muscles, and oysters, these Coralline substances effervesce with acids, and may therefore be supposed to partake of the same animal nature. But Mr. Ellis went still farther, and examined their operations, just as they were beginning. Observing an oyster-bed which had been for some time neglected, he there perceived the first rudiments of a Coralline plantation, and tufts of various kinds shooting from different parts of this favourable soil. It was upon these he tried his principal experiment. He took out the oysters which were thus furnished with Corallines, and placed them in a large wooden vessel, covering them with sea water. In about an hour he perceived the animals, which before had been contracted by handling, and had shown no signs of life, expanding themselves in every direction, and appearing employed in their own natural manner. Perceiving them therefore in this state, his next aim was to preserve them thus expanded, so as to be permanent objects of curiosity. For this purpose he poured, by slow degrees, an equal quantity of boiling water into the vessels of sea water in which they were immersed. He then separated each polypus with pincers from its shell, and plunged each separately into small crystal vases, filled with spirits of wine mixed with water. By this means, the animal was preserved entire, without having time to contract itself, and he thus perceived a variety of kinds, almost equal to that variety of productions which these little animals are seen to form.

He was thus able to perceive and describe fifty different kinds, each of which is seen to possess its own peculiar mode of construction, and to form a Coralline that none of the rest can imitate. It is true, indeed, that on every Coralline substance there are a number of polypi found, no way resembling those which are the erectors of the building.

But, in general, the same difference that subsists between the honeycomb of the bee, and the paper-like cells of the wasp, subsists between the different habitations of the Coral-making polypi.

With regard to the various forms of these substances, they have obtained different names from the nature of the animal that produced them, or the likeness they bear to some well known object, such as CORALLINES, FUNGIMADREPORES, SPONGES, ASTROITES, and KERATOPHYTES.

When examined chemically, they all discover the marks of animal formation; the Corals, as was said, dissolve in acids, the Sponges burn with an odour strongly resembling that of burnt horn. We are left somewhat at a loss with regard to the precise manner in which this multitude of cells, which at last assume the appearance of a plant or flower, are formed. If we may be led in this subject by analogy, it is most probable, that the substance of Coral is produced in the same manner that the shell of the snail grows round it; these little reptiles are each possessed of a slimy matter, which covers its body, and this hardening, as in the snail, becomes a habitation exactly fitted to the body of the animal that is to reside in it; several of these habitations being joined together, form at length a considerable mass, and, as most animals are productive, in proportion to their minuteness, so these multiplying in a surprising degree, at length form those extensive forests that cover the bottom of the deep.

BOTANY.

CHAP. XVII.

Botany, considered in its details, treats of the elements, of the immediate principles, of the internal and external structure, of the functions, of the organs, and of the similitudes and dissimilitudes, of the almost infinite multitude of beings of which the vegetable world is composed.

Chemistry explains the constituent elements and the immediate principles of vegetables; anatomy and physiology indicate the structure of their system, and the uses of their parts; botany, properly so called, teaches us to compare, to describe, and to name plants, and to class them according to the mutual affinities which are indicated by their external characters.

In this article it is not proposed to enter into any investigation of chemical botany, which has no practical relation to the study of the science, and which more properly forms a part of the science of chemistry. The heads into which the following remarks will be divided are, 1. The analogy of the science; or of the differences which exist between vegetables and other animated beings, and of their resemblances. 2. The anatomy and physiology of plants. 3. Pure botany, comprehending the theory and principles of the science, its terminology, and its classifications.

OF THE ANALOGY OF THE SCIENCE.

The district of the naturalist is confined to what are called the three kingdoms of nature; and no limits can appear more certain or decided than those within which these kingdoms are confined. The *mineral* kingdom is composed of brute matter, and is only susceptible of increase, by the juxtaposition of the substances which combine in its formation. *Vegetables* are furnished with organs, by means of which they assimilate and adapt to their purposes the elements which surround them; but, fixed by the hand of nature to one spot, they are incapable of other movements than those which are peculiar to their organization, or than those which are communicated by neighbouring bodies. But *animals* which are endued with similar properties in many respects, and which are propagated in like manner by peculiar organs, are also furnished with instinct, which teaches them how to distinguish their aliment, and to move from place to place. But do these limits absolutely exist in nature, or are they the imperfect creatures of the mind of man? And is not all nature connected by an inconceivable and inextricable multitude of affinities, crossing and interlacing each other in all directions, in such a manner as to render it impossible for us to circumscribe any one of her works within bounds so absolute that she will not be found overleaping them in some corner or another? It will probably be found that the affirmative is the answer to these suggestions, and that the deeper becomes our knowledge of the productions which occupy our minds, the more numerous the exceptions will be found to every law by which man in his ingenuity has fancied that he has fettered those operations of nature from which his own existence has been derived.

What, for example, is a vegetable? This word is in every body's mouth, and yet no one has hitherto been able to define it in so exact a way as to fix the certain line by which the vegetable is to be distinguished from the animal. In this respect, men of science are not to be separated from the multitude, except that they have acquired the habit of doubting, to which they have been conducted by study and meditation.

The division of minerals, vegetables, and animals, already spoken of, has been long admitted; and if we judge only by our first impressions, the distinction is not to be shaken. There is certainly something imposing in that simple manner of regarding the works of the creation; but, if we think upon it scrupulously, we shall be at no loss to perceive that it cannot be applied with precision, as we have no means of ascertaining at what particular point either sensation or sensibility cease to exist.

For this reason many modern philosophers reject the division of the three kingdoms, and admit only two great classes, of organic and inorganic substances. The latter class embraces all brute matter; fluids, gas, minerals. The moleculæ of which these are composed are subject to the laws of chemistry, physics, and mechanics. The other class includes animals and vegetables; their constituent moleculæ are in a perpetual state of motion. The organized particles of which these moleculæ are constituted are irritable, that is to say, susceptible of contraction, upon the application of peculiar stimulants; a wonderful power, the effects of which we are daily called upon to admire, but the first cause of which, like all other first causes, is beyond the perception of the human mind, and is designated by the appellation of the vital principle.

Endowed with this power, an organic body is able to

offer resistance to such external causes as are prejudicial to it, to reject such substances as are useless or hurtful, to select those which are best adapted to its nature, to associate and dispose them according to the laws of its peculiar organization, to communicate to them the motion which animates its moleculæ, to increase in volume, and finally to reproduce other beings of the same nature as itself. In the opinion of an ingenious Frenchman, the process of generation and nutrition, rightly considered, are two modifications of one and the same phenomenon. It is, therefore, irritability which distinguishes to our perception animals and vegetables from brute matter. But if irritability is absent, no fixed line of demarcation can be assigned.

Brute matter is formed by the attractive power of its elements. Organic bodies owe their existence to beings of their own kind. The first ceases to exist whenever the powers of chemistry or mechanics become greater than those by which the aggregation of the moleculæ of matter is maintained. The second perish when the organs accessary to their existence lose their irritability.

The limits of organic and inorganic bodies may, therefore, be considered to be ascertained with tolerable, if not with rigid, precision. The differences between vegetables and animals must now occupy our attention. A glance at the peculiarities of each will show in what these differences consist.

If we cast our eyes only upon the higher orders of plants and animals, in which organization is in its highest state of perfection and developement, no difficulty will be found in perceiving how wide a difference reigns between them. But in the lower orders of each, these differences vanish away. We will consider the connexion of animals and vegetables, both in their most perfect and most imperfect state.

And, firstly, their most perfect state of organization. Carbon, oxygen, hydrogen, and occasionally azote, constitute the basis of vegetables. Occasionally metallic oxides, and some alkalies and earths are found also, but they exist in very minute quantities, and cannot be said to form any part of the peculiar character of vegetables. Animal matter offers the same compound; but differs remarkably in this, that while carbon is in excess in vegetables, azote is in excess in animals. A vegetable is wholly composed of an homogeneous, transparent, flexible, colourless substance, forming a mass, in which, by the aid of powerful microscopes, we are able to detect no other organization than what is caused by the cohesion of an infinite multitude of tubes or cells, of various conformation. In animals, the structure is far more complex. Three organic elements enter into their composition. The first is the cellular tissue, which is a mass of membranous and continuous cellules, the cavities of which communicate with each other through pits or perforations in their sides; the second is the irritable fibre, consisting of long filaments, evidently possessing a power of contraction, composing the muscles by their union, and lining the arterial tubes and the intestinal canal; the third is the medullary substance; an homogeneous pulp, which presents to the eye when examined through a microscope, a conglomeration of minute globules. The brain, the spinal marrow, and the nerves, are composed of this substance. Animals are furnished with an intestinal canal, usually open at each extremity. One orifice is for receiving aliment, the other for voiding that part of the food which is useless for nutrition. The intestinal canal is furnished, for a part of its length, with pores, which absorb the nutritive moleculæ, and throw them into "the torrent of circulation." Plants have no intestinal canal, and their ab-

sorbent pores are diffused over all parts of their surface. For this reason, Aristotle and Boerhaave designated plants by the title of animals turned inside out.

But, if we consider the distinctions between those animals and vegetable substances which are imperfect in the greatest degree, we shall find that nearly all these discrepancies are nonexistent. The infusorial animalculæ are, for the most part, formed with nothing more than an intestinal canal, with two foramina; or, as a well known writer has observed, they are all stomach. Among plants, the genera Palmella, Echimella, Protococcus, and many others, possess the same simplicity of anatomical structure. The power of motion, which is believed to be the peculiar attribute of animals, equally exists in the genus Oscillatoria of vegetables. The propagation of the polype, by separation into many parts, is precisely the mode of increase which takes place in many Confervæ. As to the distinction of irritability in animals, and nonirritability in vegetable bodies, it is one of those problems which, perhaps, will never be solved. That the presence of nervous and muscular fibre is not essential to even animal irritability, as some have supposed, is obvious from the infusoria, in which neither muscle nor nerve exist, and which are, notwithstanding, endued with irritability. It is probable that every organic body, which possesses the capability of developement, is, from that circumstance alone, irritable, although the power of contraction may not be always manifest; for nutrition, or the power of assimilating foreign substances, and incorporating new moleculæ with themselves, which living beings possess, and of subjecting them to the laws of organization, of necessity supposes a force of suction which attracts the nutritious juices. But how is suction to take place otherwise than by he alternate contraction and expansion of the

absorbent vessels? The phenomena of nutrition are, therefore, a proof of irritability; and since plants increase, it is clear that they possess powers of nutrition, and consequently are irritable. Besides which, many exhibit motions, as in the Oscillatoria, above alluded to, and in the common sensitive plant, which cannot be explained upon the ordinary laws of phyics, and which may be supposed to result from a power of contraction, of what may be called the muscular fibre.

Plants are operated upon in the same way as animals, by the application of poisonous or corrosive substances. M. F. Marcet of Geneva has lately published the result of some curious experiments respecting the effect of both mineral and vegetable poisons upon the system of vegetables. His observations were chiefly made upon the common kidney bean (Phaseolus vulgaris), and a comparison was always made with a plant watered with spring water. From these experiments M. Marcet concludes, 1st. That metallic poisons act upon vegetables nearly as they do upon animals. They appear to be absorbed and carried into different parts of the plant, altering and destroying the vessels by their corrosive powers. 2d. That vegetable poisons, especially those which have been proved to destroy animals by their action upon their nervous system, also cause the death of plants. Whence he infers that there exists in the latter a system of organs which is affected by poisons nearly as the nervous system of animals.

In sensibility, as distinguished from irritability, or in the possession of a nervous system, there is now scarcely room for doubting that plants agree with animals. The discoveries of Dutrochet show that in the system of vegetables a matter exists which is altogether analogous to the nerves of animals. The latter are composed of an agglomeration

of an infinite number of minute globular particles, which are concrescible by the action of acids, and resoluble by the application of alkalies. In the sensitive plant, Dutrochet has ascertained that sensibility depends upon the presence of a vast number of particles, which are affected by chemical agents in the same way as the nerves of animals. They line the cellular tissue, and are plentifully distributed over the tubular and spiral vessels, or tracheæ.

Neither can the power of perception be denied to exist in some plants, in as distinct a state as in many animals. We see that the former move, that they seize little insects, that they retreat from the approach of danger, and that they appear to possess a faculty of selecting that nourishment which is best adapted to the peculiarities of their structure. Can any one attribute the power of sense to Zoophytes, to Corallines, and deny its existence in the Dionæa, or the sensitive plant? is it possible to ascribe it to the Infusoria, and to refuse it to Oscillatorias? surely, no argument can be employed in justification of such an opinion, except such as may be deduced from analogy. And let us see to what such an argument may be imagined to amount.

On one hand, considering that zoophytes perform motions precisely similar to those which are peculiar to animals visibly provided with nerves and muscles, we should conclude that the motions of zoophytes have a similar origin; and on the other hand, bearing in mind that the small number of plants which perform what appear to be voluntary motions are, in all apparent respects, organized in just the same way as other plants which have no such motion, we are equally justified in inferring that those plants in which no motion is observable have the same power of contraction as the others, but in an insensible degree.

In their different modes of generation animals and plants

are remarkably similar. Envelopes more or less hard and numerous; an embryo concealed within these envelopes; a small quantity of nutrition ready prepared for the early use of the young being; these are common both to the seed and the egg. A double foramen exists in the ova of many of the lower animals, as in frogs; it is equally present in the seed, or ovula, of nearly all plants. If almost all animals have eggs, so have almost all plants seeds.

Many vegetables have no seed; many animals have no eggs. Both are multiplied by the extension and natural separation of their peculiar substance. On the surface of many polypes are found little tubercles, which generally enlarge, become detached, and form, at a greater or shorter distance from the parent stock, other polypes, which soon become capable of increasing by the same means. Confervæ are known, in several cases, to increase in precisely the same way. Of what degree of precision then is the most perfect of the following definitions of a plant, proposed by observers who are placed at the head of their science? Stones grow; vegetables grow and live; animals grow, live, and have perception. *Linnæus.* A plant is a compound organic body, deriving nourishment from the soil in which it grows. *Link.*

THE ANATOMY AND PHYSIOLOGY OF PLANTS.

Without entering, in this division of the subject, into all the differences of opinion with which botanists have occupied the world, it will be enough to explain, in a clear and sufficient manner, those principles of vegetation, and laws of vegetable increase, which are now believed to be correctly ascertained. In this department, the writings of Aubert du Petit Thouars, a distinguished French philosopher, are considered as those which contain the most correct views of the progress of nature.

Not to occupy ourselves with the immense variety of forms which cover the whole face of the globe, it will be more convenient, and equally useful, to confine our attention to a single species. For this the commonest weed will answer the same purpose as the stateliest tree of the tropics.

After considering its external organs, let us examine its interior, and seek to discover the manner in which they contribute to its existence. By comparing it with other plants, we shall be enabled to determine what it has in common with them, and what are its peculiarities; thus we shall at once acquire an idea of its essential characteristics, and of its differences. By enlarging a little upon the functions of all the organs of a plant, under this part of our article, it will be only necessary under the head of Pure Botany to enter into the modifications of organs, without further reference to their nature and purposes.

Take a plant at hazard, the first you meet with by the path: it will be found to possess a root, which fixes it to the ground, and which buries itself in the earth; and a trunk, or stem, which elevates itself in the air. The latter is furnished, at intervals, with leaves which are remarkable for their thinness, and their green colour. Near the point where they leave the trunk, is placed a body which is protruded from it also. Without any determinate figure at first, it gradually developes, and produces new leaves similar to those from which it proceeded; and, gradually separating the leaves from each other, it stops by forming a second stem. This stem is a branch. Each new leaf being supplied with a similar body, or bud, is capable of producing a new branch, unless prevented by injury or accident. This, therefore, is the plan upon which the plant we are examining increases in size; but the changes of this

nature which it undergoes have little effect upon its peculiar characteristics, they only render it of greater or smaller size. But a more remarkable epocha presently arrives. Buds make their appearance of a very different nature from those which formerly produced branches; they insensibly increase in size, and at a fitting hour, when they have arrived at their greatest growth, the delicate parts which they contain, burst through the scales which envelope them, and expand themselves; these are the flowers. They are no longer of a monotonous uniform green colour, but they assume the most lively hues, they exhale the most delicious fragrance, and they surprise us by the complex mechanism which they contain. But their duration is brief. Of all the parts of which they were composed, one only remains, which is the pistillum, and which fills the centre. When all the rest are withered, this alone assumes new life, and, after a gradual increase in size arrives at maturity, and becomes the fruit. The latter encloses bodies which separate from it at the period of maturity, and which are the seeds.

Each of these seeds placed in the earth, and submitted to the effects of time and circumstances, undergoes the process of germination; that is to say, absorbing, or, as some have it, pumping up humidity, through channels which are invisible to our senses, it swells until it bursts through the coverings in which it is encased. Then a new body makes its appearance. This is the embryo or rudiment of a new plant; it is formed of two portions; the one a cylindrical or conical oblong body, and the other two leaflike, processes applied closely upon each other. The cylindrical body lengthens, and endeavours to bury itself in the earth; whatever may be the position in which the seed is placed, it finally attains this purpose, and, penetrating

the soil, becomes a real root; whence the name of radicle, which is applied to this organ when in a state of rest. The two leaflike processes separate, and assume a horizontal direction; they are the cotyledons. In their centre is to be seen a sort of little bud, which is called the plumule, and which is the parent of subsequent leaves; those which it first developes are rather different from those of the plant which produced itself; but in the end they become identical, and a new plant is produced, in all respects the same as that by which the seed was originally borne.

Having now examined the exterior of a plant, it is time to consider its internal structure. For this purpose it is as well to continue our observations on the little plant which has just emerged from the seed. In its state of infancy and seclusion, the radicle, when cut across, offers nothing more than a succulent homogeneous substance. As soon as it has advanced, and touched the earth, and pushed forth some young roots, if it is broken across, it will be seen that it is then divided into two distinct parts; namely, a cylinder covered over with a sheath, which appears capable of being separated from it in all points. If the plant has also produced young branches, they too, when cut across, exhibit a similar appearance; that is to say, upon their first coming forth they will be found solid and homogeneous, and presently afterwards they will be seen to consist of a solid cylinder, and of an external case. After all these parts have arrived at a further period of their growth, another difference will be observable. A transverse section then exhibits two concentric circles; the inner enclosing a spongy and rather dry cylinder, the exterior a sheath, which is firmer and of a whitish colour; besides which will be seen the separate case which was distinguishable from the earliest developement of the plant, and which has now become

whitish in the inside, but which retains externally its succulent texture and green colour. The rest, however, continues to manifest its two original divisions only, which are always white or some other colour, but never green.

Here then we have three distinct parts: that in the centre is the pith; the case which surrounds it is the ligneous substance, or the wood; and the external covering is the bark. In the root the pith is absent. But are these parts actually as distinct as they appear to be to the naked eye? In the infancy of the plant we have seen that they were not separate. By what means then have they become so?

At the period when they appear most distinct let us examine the pith with a pocket lens. We shall perceive that it consists of a mass of little bladders, or cells, the section of which exhibits a figure more or less hexagonal, and which constitute polyhedral figures, the sides of each of which appear to be common to two cells. They are not so, however, in fact; each polyhedral cell being, as is now known, distinct and separable from those next it, with which it is only in a state of cohesion. Following the direction of these cells with care, it will be seen that some of them pass horizontally though the ligneous substance, and lose themselves in the bark; if no trace of these appears on the surface of the wood when the bark is stripped off, that will be attributable only to the extreme tenuity of the traversing cells, which, snapping asunder upon the slightest violence, leave no perceptible vestige, and offer no sensible resistance. If they are traced in the bark itself, it will be found that they maintain a connexion with the external part of it, where they form a continuous layer, which is what preserves that green colour which is always obvious on the outside.

The only difference which exists between these parts is, that the centre has expended all its juices, and that the outside of the bark preserves them. In this state the latter

receives the name of parenchyma. But, with the feeble nature and slight texture which it possesses, in what manner can it be conceived that the pith penetrates the woody substance which seems to be so solid? The first glance is sufficient to explain this phenomenon. There is no sort of difficulty in seeing that the wood is composed of parallel fibres, which interlace each other, and form a kind of network, through the meshes of which the parenchyma, or the medullary elongation, finds its way to the bark. There it meets with a network of matter far more flexible than that nearest the pith, and composing all the interior of the bark: this latter is named the liber.

There is still an essential part of the bark to notice, which is the epidermis. This is easily discovered. All the interior parts of a plant seem both to the eye and the touch saturated with glutinous juices, while the external part is wholly dry. This state of dryness arises with the epidermis, which consists of an exterior membrane, enclosing and holding together all the solid and fluid parts. It originally existed in the embryo, and it continues to cover, without interruption, all the parts subsequently developed. Even the leaves themselves, so delicate and attenuated, are covered over both surfaces with two united skins of this epidermis. The expansion or dilatation to which they are subject proves this fact, and makes them excellent evidences of it.

The part by which the leaf is attached to the stem, and which is named the petiole, appears to be composed of a bundle of fibres. The petiole extends from one end to the other of the leaf, and separates it into two nearly equal parts. It diminishes in diameter as it approaches the end of the leaf, because it from time to time sends off young branches from each side, which themselves become subdivided, and, by crossing each other in various directions, form a kind of continuous network.

Accident, insects, or a very sharp instrument, will separate the epidermis. It then appears in the form of an extremely thin and perfectly transparent membrane. The green colour which it exhibits in its natural state is not proper to itself, but is caused by the succulent substance which is interposed between the meshes of network. In the latter there is no difficulty in recognizing the parenchyma in a state of vegetation; for it is certain that the green colour is the constant attendant of that state, and that by its means the parenchyma may be discovered wherever it exists.

The fibres which form this network proceed from the petiole; but whence does the petiole itself derive its origin? It appears to spring from the bark; in that case would it be any thing more than the meshwork of the liber in a state of developement? Such has been the opinion of some writers; but if its origin be carefully traced, it will be found to arise within the woody substance itself; and to be in fact a detached portion of the wood.

The phenomena which took place at the period of germination are renewed by every leaf which successively unfolds itself. The cotyledons were the source of the fibres which were sent down into the earth through the root; in like manner every leaf is enabled to maintain a communication between itself and the soil by the means of fibres. Hence arises another kind of increase, of which no notice has yet been taken; the increase in thickness. A stem which at the hour of its birth was no thicker than a pin, in a few months acquires the diameter of an inch or more. This arises from the successive superposition of the bundles of fibres, which are created upon the developement of each leaf, and of every leaf-bud. The latter makes its first appearance under the form of a green point, which originates from the inner layers of the ligneous

body, which it traverses, and penetrates into the bark. A short time after its first appearance, it may be perceived that the bud is surrounded by a portion of woody fibre, which passes downwards, covers over the wood previously formed, and thus forms a new layer. The existence of this is easy to demonstrate; for the fibres of the leaves separate easily from the wood, but the leaf-buds when broken off evidently arise from the interior of the wood. All the new parts formed by the leaf-bud soon become so completely identified with the old wood, that, after a short period, no marks of separation remain.

We have now followed the plant through all its stages of increase. We have next to consider what the source is from which it has obtained the substances it has assimilated. There can be no doubt that the roots, which penetrate into the earth, contribute much to this purpose: for a long time, indeed, it was believed that plants were capable of absorbing even earth itself. But more accurate observation has shown that nothing but humidity can be carried up into the plant through its roots. Mere humidity, however, is insufficient to maintain life and health in a plant. Experiments have been tried to induce plants to exist with their roots plunged into water only: they all proved abortive, although in some cases life was maintained in the subjects of the experiments for several years. Various substances or agents, in combination with humidity, doubtless afford the nutriment upon which vegetables live. But by what curious mechanism is the requisite humidity conveyed to the parts which require it?

In the rapid glance which has been cast upon the internal structure of plants, we have perceived nothing more in the ligneous body and the liber of the bark, than elongated fibres which cross each other and form a network. Of this we may be convinced with little trouble, by exam-

ining against the light with a pocket lens, a very thin transverse section of a branch. It will be seen to be pierced full of holes, of different forms and sizes; these are the extremities of as many continuous tubes. The true structure of these tubes is much a matter of conjecture and dispute; some observers discover an infinite variation of figure and organization; others reduce them all to the woody fibre and the spiral vessels or tracheæ. While one microscopic botanist sees pores and holes in the sides of these tubes, simple tubes, mixed tubes, and many more; others declare that the pores are imaginary, the difference nonexistent, and that all the tubes are essentially the same. In this war of observation, which, however curious as a matter of speculation, bears very little upon the most important part of vegetable physiology, or upon the functions of parts, we shall at present content ourselves with one kind only, which is easy to observe. Twist a young shoot so as to break it with as little violence as possible, and the two separated parts will be found to be held together by extremely delicate threads. If you consider them with care, you will find that they are each one a simple thread, rolled up in an admirable manner in the way of a corkscrew. The spires of this screw being closely applied to each other, it forms a continuous tube; vessels of this kind are called spiral vessels, and are found in the nerves of the leaves, or in the bundles of vessels in communication with the leaves. It was long thought that in these parts a striking analogy was perceptible between animals and plants; and a comparison was drawn, apparently with reason, between the spiral vessels of plants, and the tracheæ of animals, especially of insects which are constructed in a very similar manner. It was, therefore, inferred that these were the respiratory passages of plants, but experience has not confirmed this notion. Nevertheless, it is certain

that air acts a great part in the economy of vegetation, and that it is by the leaves that its influence is manifested. They have a direct communication with the roots, whither all their intermediate tubes extend; and the pores which terminate them may be seen with different degrees of facility, according to circumstances. By their agency the humidity which is sucked from the earth is raised, and forms what is called sap, which deposits successively all that is necessary for the supply of the different parts through which it passes. Having arrived at the leaves, a portion escapes by perspiration, a portion is deposited, and the remainder descends, charged with new principles, which the leaves have absorbed from the surrounding atmosphere. The leaves therefore contribute to the increase of the plant. When this motion of the sap is once established it continues to increase; and it is supposed that the superfluous power which it has acquired occasions the production of new branches and of flowers.

But what is the cause of this motion? The most obvious is heat, which, by dilating those upper points, which are most subject to its action, occasions a void in them; the juices which are below them ascend to replace the void, and the continual recurrence of this operation occasions what we call the circulation or motion of the sap. This mechanical action will be a sufficient explanation for those who are contented with looking only at the surface of things; but it will not explain all the difficulties connected with the motion of the sap; and especially will it not account for the first tendency of the radicle to the earth, on which tendency all subsequent phenomena necessarily depend; of such a tendency, gravitation and a thousand other laws have been offered as an explanation, each being more unsatisfactory than the other. Surely it is wiser at once to admit that it depends upon that inherent principle of

life which is peculiar to organic matter, which accompanies the vegetable through all stages of its existence; and which is infused into those new individuals which the parent produces. It is a first impulse received in the beginning of its existence, which has extended into every part, and which finally passes into the seeds. It is that first creative impression to which it owes the faculty of assimilating the various moleculæ of matter, and of applying them; by whose influence the roots are directed towards the side where the most fitting nourishment is to be found; which compels the leaves to present their upper surface always to the light; which induces many to assume that peculiar position during the night which has been compared to the sleep of animals; and finally, which gives rise to those various phenomena of vegetation which seem to distinguish plants from the general laws of physics.

There are many other instructive ideas which may be obtained from the consideration of a single plant; but they, perhaps, will be best understood by a comparison with other plants; and by ascertaining, by that means, whether all are formed upon the same plan, composed of the same parts, and subject to the same changes.

One of the most obvious contrasts presented by the vegetable kingdom, is between the tribes which rapidly expand their foliage, and push up their flower-bearing stems, and by bringing their fruit to perfection fulfil the purpose of their creation in the space of a few months, or even weeks, and those monarchs of the forest which bear aloft their majestic branches in the air, and see centuries passing by them, while generation after generation of herbs, and even men, are perishing at their feet. One would think that if any thing could indicate a difference of organization, it would be peculiarities like these. In fact, if we examine one of these vegetable colossi, which storms or other acci-

dents have levelled with the earth that was so long over-shadowed by its branches, we perceive that its interio consists of a solid, compact, homogeneous substance, whicl seems to be analogous to nothing in the annual plant; w also see, however, that a section of this substance is marke by concentric circles. In order to ascertain the origin o these circles, it is necessary to revert to the seeds, whicl such a tree produces in vast abundance. There we dis cover the same parts as in the annual plants; two cotyle dones; a cylinder, which attempts to fix itself in the eartl by the production of roots; and an intermediate bud. Th impulse once given to its developement, this seed, with it apparently feeble resources, will become in the lapse o years and ages similar to that giant which produced it. In the leaves and buds consist the sources of its magnitude the former being under the necessity, on the one hand, o coming into contact with air, and on the other of establish-ing a communication with the soil, establish the action o vegetation. The first year passes on as in the annua plant, except that the parts of the tree are unfolded wit less rapidity, and that the buds present neither flowers no fruit, but a tree covered with scales. Upon the arrival o winter the annual perishes, the tree loses only its leave As soon as the season again becomes milder, vegetatio which had been suspended, is renewed; the buds insens bly expand, and the unfolding of new leaves gives a nev life to the plant; each of these leaves is accompanied b its bud. Thus each successive season, producing a ma of foliage, which increases by a rapid geometrical progres sion, and an equal number of new buds, occasions the for mation of a new body of ligneous substance, which over lays the whole body, and thus forms the whole tree into kind of cone.

The whole mass of the wood is thus composed of thin successive cones. They are easily perceived in many trees, and it is they which form those concentric circles observable in a trunk cut across. Each circle, depending wholly upon the increase caused by the return of successive seasons, becomes a sure testimony of the age of the tree.

The principal part of our trees exhibits these laws of developement. The buds may be more or less apparent; and the scales which enclose them may be more or less numerous, being increased in number in proportion to the greater sensibility of the organs they enclose. For a more sure protection, the scales are often covered with glutinous or resinous exudations. But even with this safeguard, the fostering hand of nature does not rest. Thick furs are frequently interposed during the winter among the buds, and are thrown over the tender shoots.

By this means the buds remain safely upon the tree. We generally remark one which is a termination of the branch, and which will the following year prolong the branch in its original direction; all the others are seated at the axillæ of the leaves.

Trees present many peculiarities, which depend upon their woody state. The pith, which occupies the centre of young plants, disappears in trees. It is probable that, besides the increase in diameter which takes place externally, some peculiar operation goes forward in the inside, and that the solid layers of wood compress the pith in such a way as to leave scarcely any traces behind. Around it vegetation is evidently maintained for a long time, as is shown by the green tinge which surrounds it. Larger and more obvious vessels are placed about it than elsewhere, and constitute what is called the étui médullaire by the French, which there is reason to think is one of the most important accessories of vegetation.

The wood does not at once arrive at that solidity which it subsequently possesses, but acquires it by slow degrees, from the centre to the circumference. For this reason the external layers are much less compact, and paler than the internal; they are called the alburnum. Dutrochet accounts for this difference in the old and new layers of wood with his usual sagacity. He is of opinion that a portion of the sap, elaborated and sent downwards by the leaves under the state of proper juice, is absorbed laterally by means of the radiating vessels or silver grain, and is gradually deposited in the originally empty vessels of the wood; that the compactness and weight of wood depend upon these juices so deposited, and not upon any constitutional difference in the wood itself; and that in certain trees, which are remarkably light, as the poplar, no deposit, or scarcely any, takes place.

The bark also undergoes material changes in the course of time. The first branches which are produced are green like the leaves; their colour being occasioned by the transparency of the epidermis, which allows the cellular tissue, or the parenchyma, to show through. By slow degrees the epidermis thickens, and assumes a deeper colour, under which appearance it is seen in the winter season. If it is raised up, the green colour of the parenchyma is still manifest enough beneath it. The epidermis necessarily gives way gradually to the growth of the tree, and splitting in various directions is replaced by another; and by [illegible] degrees new layers are formed, and burst in various directions. According to the nature of the plant the epidermis also takes a variety of forms, sometimes forming the [illegible] shapen knotty crust which is usually called bark, sometimes peeling off in thin layers, and occasionally falling from the parent tree in hard flakes.

It is probable that the bark performs the same functions

as the leaves, in the early state of the buds, and occasionally in all states. Otherwise it would not be easy to account for the growth of cacti, euphorbias, some apocineous plants, &c. which are all destitute of leaves. In fine, the bark may be compared to a universal leaf, with one surface only.

We have seen what ingenious methods nature adopts to screen the buds from the rigour of winter; but in countries where there is no winter, no defence is requisite. These protecting scales diminish, therefore, by degrees, as we approach the equator. In the trees which cover countries in such a latitude, the buds break forth at once into leaves and branches, without regarding the order of seasons. By this circumstance the apparent difference between trees and herbs is removed.

In like manner, insensible gradations unite the herbs which creep or trail along the ground, and those which carry their heads aloft in the air: the perennial and the annual vegetable. Some exist for two years. The stems of others perish every year, but their roots survive. Some under shrubs scarcely elevate themselves from the soil, yet their slender stems are formed of a firm and woody substance. Next come the shrubs whose branched and entangled stems form bushes. Lastly are perfected the trees, which, from possessing a stem scarcely loftier than the stature of a man, finally dilate themselves till they become the giants of the forest.

We have assigned, as the cause of increase in the bulk of trees, the communication which is established in their system between the leaves and roots. The reciprocity of disposition of these two organs is so strong, that if a bit of a branch of any tree which is robust enough to bear the operation, be placed in the earth, it immediately makes good the loss it has sustained by being dissevered. It

presently produces fresh roots, and a new plant is formed. The advantage which is taken of this peculiarity of plants, to propagate them by cuttings or layers, is well known. But this is not all; a bud separated from its parent, and inserted between the bark and the wood of another tree, soon establishes the requisite communication between itself and the earth, and renders the tree which bears it similar in nature to the kind artificially inserted. Hence the origin of budding and grafting in horticulture.

From these observations it has become evident that the life of a plant is a succession of several lives; and that the greater proportion of its parts consists of an intermediate system, which only serves to maintain a communication between the extreme points of the vegetable. If a tree is destroyed by the ravages of time, its death can be only occasioned by the destruction of the intermediate portions of its fabric, by which the channel of continuous communication is effectually interrupted. After such interruption has taken place, the still surviving portions of the tree are capable of furnishing layers or cuttings, which will renew the operation of vegetation with unabated vigour.

The resources of nature are far from being exhausted by these apparent buds; there exists throughout the vegetable system a creative and expansive power, which, according to circumstances, is able to operate in the developement of new buds, where none had been visible before. In fact, there is always an abundance of rudimentary buds dispersed among the substance of a tree, which are only called into action when the ordinary resources of nature begin to fail. They are frequently excited very long after the period which had been originally assigned for their appearance; and even in places where no traces of them could have been expected to exist. Thus in all vegetables there appears to be as obvious a line of demarcation in the

system, at that point which is called the collar, whence the first ascending fibres direct their course upwards, and the descending downwards. Buds are only produced by the former, and form no part of the economy of the latter. Yet it not unfrequently happens, that roots exposed in a proper degree to the influence of the air will form buds, and throw up shoots, in the same way as the branches. Even the leaves have, in a few cases, a similar power of producing buds, and consequently young plants.

We have now seen that the growth of plants, and their increase in size, depend upon a peculiar internal movement, acting between the leaves and the roots. But in what way does it operate? This is a problem which has exercised the ingenuity of all students of vegetable physiology, who have contrived theories innumerable to explain the phenomenon which is called the circulation of the sap.

The great and almost impenetrable obscurity in which this subject is unavoidably involved, has occasioned much diversity of opinion among phytologists. Grew states two hypotheses, which he seems to have entertained at different periods, though it is not quite certain to which of them he finally gave the preference. In one of them he attributes the ascent of the sap to its volatile and magnetic nature, aided by the agency of fermentation; but this hypothesis is by much too fanciful to bear the test of serious investigation. In the other he attributes the entrance and first stage of the sap's ascent to the agency of capillary attraction, and accounts for its progress as follows: the portion of the tube that is now swelled with sap, being surrounded with the vesiculæ of the parenchyma, swelled also with sap, which they have taken up by suction or filtration, is consequently so compressed, that the sap therein is forced upwards a second stage, and so on till it reaches

the summit of the plants. But, if the vesiculæ of the parenchyma receive their moisture only by suction or filtration, it is plain that there is a stage of ascent beyond which they cannot be thus moistened, and cannot, consequently, act any longer upon the longitudinal tubes. The supposed cause, therefore, is inadequate to the production of the effect.

Malpighi was of opinion that the sap ascends by means of the contraction and dilatation of the air contained in the air vessels. This supposition is perhaps somewhat more plausible than either of Grew's; but, in order to render the cause efficient, it was necessary that the tubes should be furnished with valves, which were accordingly supposed; but of which the existence has been totally disproved by succeeding phytologists. If the stem or branch of a plant is cut transversely, in the bleeding season, it will bleed a little from above as well as from below: and if the stem of any species of spurge is cut in two, a milky juice will exude from both sections in almost any season of the year. Also if a plant is inverted, the stem will become a root, and the root a stem and branches, the sap ascending equally well in a contrary direction through the same vessels; as may readily be proved by planting a willow twig in an inverted position. But these facts are totally incompatible with the existence of valves; and the opinion of Malpighi is consequently proved to be groundless.

The next hypothesis is that of M. De la Hire, who seems to have attempted to account for the phenomenon by combining together the theories of Grew and Malpighi. Believing that the absorption of the sap was occasioned by the spongy parenchyma, which envelopes the longitudinal tubes, he tried to illustrate the subject by means of the experiment of making water to ascend in coarse paper, which it did readily to the height of six inches, and by particular man-

agement even to the height of eighteen inches. But, in order to complete the theory, valves were also found to be necessary, and were accordingly summoned to its aid. The sap which was thus absorbed by the root, was supposed to ascend through the woody fibre, by the force of suction, to a certain height; that is, till it got above the first set of valves, which prevented its return backwards; when it was again supposed to be attracted as before, till it got to the second set of valves, and so on till it got to the top of the plant.

This theory was afterwards adopted by Borelli, who endeavoured to render it more perfect, by bringing to its aid the influence of the condensation and rarefaction of the air and juices of the plant, as a cause of the sap's ascent. And on this principle he endeavoured also to account for the greater force of vegetation in the spring and autumn; because the changes of the atmosphere are then the most frequent under a moderate temperature; while in the summer and winter the changes of the atmosphere are but few, and the air and juices either too much rarefied, or too much condensed, so that the movement of the sap is thus at least prejudicially retarded, if not perhaps wholly suspended. But as this theory, with all its additional modifications, is still but a combination of the theories of Grew and Malpighi, it cannot be regarded as affording a satisfactory solution of the phenomenon of the sap's ascent.

With this impression upon his mind, and with the best qualifications for the undertaking, Du Hamel directed his efforts to the solution of the difficulty, by endeavouring to account for the phenomenon from the agency of heat, and chiefly on the following grounds: because the sap begins to flow more copiously as the warmth of spring returns; because the sap is sometimes found to flow on the south side of a tree before it flows on the north side; that is, on the

side exposed to the influence of the sun's heat sooner than on the side deprived of it; because plants may be made to vegetate even in winter, by means of forcing them in a hot-house; and because plants raised in a hot-house produce their fruit earlier than such as vegetate in the open air.

On this intricate but important subject, Linnæus appears to have embraced the opinion of Du Hamel, or an opinion very nearly allied to it, but does not seem to have strengthened it by any new accession of argument, so that none of the hitherto alleged causes can be regarded as adequate to the production of the effect.

According to Saussure, the cause of the sap's ascent is to be found in a peculiar species of irritability, inherent in the sap vessels themselves, and dependent upon vegetable life, in consequence of which they are rendered capable of a certain degree of contraction, according as the internal surface is affected by the application of stimuli, as well as of subsequent dilatation, according as the action of the stimulus subsides: thus admitting and propelling the sap by alternate dilatation and contraction. In order to give elucidation to the subject, let the tube be supposed to consist of an indefinite number of hollow cylinders, united one to another, and let the sap be supposed to enter the first cylinder by suction, or by capillary attraction, or by any other adequate means; then the first cylinder, being excited by the stimulus of the sap, begins gradually to contract, and to propel the contained fluid into the cylinder immediately above it. But the cylinder immediately above, when acted on in the same manner, is affected in the same manner; and thus the fluid is propelled from cylinder to cylinder, till it reaches the summit of the plant. So also when the first cylinder has discharged its contents into the second, and is no longer acted upon by the stimulus of the

sap, it begins again to be dilated to its original capacity, and prepared for the introsusception of a new portion of fluid. Thus a supply is constantly kept up, and the sap continues to flow.

But Mr. Knight has presented us with another, which, whatever may be its real value, merits at least our particular notice, as coming from an author who stands deservedly high in the list of phytological writers. This theory rests upon the principle of the contraction and dilatation, not of the sap vessels themselves, as in the theory of Saussure, but of what Mr. Knight denominates the silver grain, assisted perhaps by heat and humidity, expanding or condensing the fluids. On the transverse section of the trunk of woody plants, particularly the oak, they appear in the form of the radii of a circle, extending from the pith to the bark; and on the longitudinal cleft or fissure of the trunk of most trees, but particularly the elm, they appear in the form of fragments of thin and vertical laminæ, or plates, interlacing the ascending tubes in a transverse direction, and touching them at short intervals, so as to form with them a sort of irregular wicker-work, or to exhibit the resemblance of a sort of web. Such, then, being the close and complicated union of the plates and longitudinal tubes, the propulsion of the sap in the latter may be easily accounted for, as it is thought, by means of the alternate contraction and dilatation of the former, if we will but allow them to be susceptible to change of temperature; which susceptibility is proved, as it is also thought, from the following facts: on the surface of an oaken plant that was exposed to the influence of the sun's rays, the transverse layers were observed to be so considerably affected by change of temperature as to suggest a belief that organs which were still so restless, now that the tree was dead, could not have been formed to be altogether idle while it

was alive. Accordingly, on the surface of the trunk of an oak deprived of part of its bark, the longitudinal clefts and fissures, which were perceptible during the day, were found to close during the night. But in the act of dilating they must pass unavoidably on the longitudinal tubes, and consequently propel the sap; while in the act of contracting they again allow the tubes to expand and take in a new supply. This is the substance of the theory.

But, in drawing this grand and sweeping conclusion, Keith has well remarked, that it should have been recollected, that change of temperature cannot act upon the transverse layers of a tree that is covered with its bark, in the same manner as it acts upon those of a tree that is stripped of its bark, or upon those of a plank; and if it were even found to act equally upon both, still its action would be of but little avail. For, according to what law is the machinery of the plates to be contracted and dilated, so as to give impulse to the sap? According to the alternate succession of heat and humidity? But this is by much too precarious an alternation to account for the constant, and often rapid, propulsion of the sap, especially at the season of bleeding. For there may be too long a continuance of heat, or there may be too long a continuance of humidity; and what is to become of the plant during this interval of alternation? If we are to regard it as happening only once in the space of twenty-four hours, as in the case of the oak, it can never be of much efficacy in aiding the propulsion of the sap. But if we should even grant more, and admit the alternate contraction and dilatation of the vessels to be as frequent as you please, still their effect would be extremely doubtful, owing to a want of unity or cooperation in the action of different plates, or of different portions of the same plate. If heat, like humidity, entered the plant by the root, and proceeded gradually upwards, like the ascending sap,

perhaps it might be somewhat efficacious in carrying a portion of sap along with it; but as this is not the case, and as the roots of plants are but little affected by change of temperature, while the trunk and upper parts may be affected considerably, it can scarcely be supposed that the action of the plates will be uniform throughout the whole plant; or rather, it must be supposed, that it will often be directly in opposition to that which is necessary to the propulsion of the sap. But, admitting that the sap is propelled by the agency of the plates in question, and admitting that it has been thus raised to the extremity of the woody part of the plant, how are we to account for its ascent in such parts as are yet higher; the leaf-stalk and leaf, the flower-stalk and flower; as well as in the herb also, and in the lofty palm, in which no such plates exist? Here it will be necessary to introduce the agency of a new cause, to complete the work that has been thus begun, and of a new set of machinery to supply the deficiency or absence of the machinery that has been already invented.

How unsatisfactory the best of these theories is, must be self-evident, even to persons unacquainted with the structure of vegetables. Du Petit Thouars has, therefore, proposed a new hypothesis, which to us seems by far the least objectionable. He dismisses the question of the mechanical action by which the motion of the sap is maintained; thinking, with much justice, that no principle of physics, with which we are acquainted, is sufficient to explain it; and he therefore attributes the mere motion to an inherent power, with which nature has been pleased to endow vegetables. But the cause of the renewal of its motion in the spring, after remaining in a quiescent state for several months, he ascribes to the necessity of maintaining a perfect equilibrium in the system of a plant. So that, if a consumption of sap is produced at any given point, the necessity of

making good the space so occasioned, consequently throws all the particles of sap into motion, and the same effect will continue to operate as long as any consumption of sap takes place. The first cause of this consumption of sap he declares to be the developement of the buds, and already formed young leaves, by the stimulating action of light and heat, but particularly of the latter. As soon as this developement occurs, an assimilation and absorption of sap is occasioned, for the support of the young leaves; a vacancy in the immediate vicinity of the leaves is produced, and motion immediately takes place.

We will not occupy ourselves with an explanation of the cause of the descent of the sap: gravitation will serve the purpose, in the room of a more plausible conjecture.

But, notwithstanding all the differences which exist among trees, they approach each other by insensible degrees; and yet they individually retain a peculiar set of characters, and a physiognomy, which botanists call habit, that renders it easy to distinguish them at great distances; and more easy to eyes habituated to the sight of them, by practice and long familiarity, than by the aid of theory.

Hot countries are beautified, however, by a description of trees, the differences of which are exhibited in an unusual degree. In these regions exist the palms, that patrician order of plants, as Linnæus termed it, which supports an umbrageous undulating tuft of huge leaves, seated on the summit of a lofty columnar trunk. Here you have no longer an infinite division of branches, as in the trees of Europe, but a trunk of the greatest possible simplicity, covered with rigid scales, or marked by distant circles. If an observer notices a considerable number together, of different ages and sizes, he will perceive that the smallest and the youngest are entirely the same as the largest, except in dimensions. They possess an equal quantity of leaves, their

trunks are of equal diameter, and they differ only in stature. Carrying observation yet farther, it will be found that the trunk is not formed, as in European trees, of concentric circles of wood, but that it is formed by the assembly of a vast number of parallel fibres, which extend from the roots to the summit, and every one of which has its communication with a leaf. No trace of pith is discoverable in the centre, nor of liber or bark in the circumference; but the whole body of utricular or parenchymatous matter exists dispersed among the fibres.

To understand this peculiar manner of growth, recourse must again be had to the seed, and to its germination. This is easily examined, the seed of the palm-trees being often among the largest in nature. The part, however, by which reproduction takes place, is wonderfully small for the size of the seed; and lies hidden in a peculiar substance of great dimensions, which is called the albumen.

This embryo is oblong, and manifests no trace of division, or of separation, at either extremity. As soon as the period of germination arrives, the exterior extremity elongates and opens, producing a kind of sheath, from the base of which descends a root, and the other extremity of which is always retained in the albumen. This sheath encloses a second, which is rather longer; a third appears, becoming yet longer and longer; from one of the sides of the next is unfolded a kind of plaited leaf. Following each other in succession, the one from the bosom of the other, they at length assume the appearance of the adult leaves, differing from them only in dimensions. The parts of the leaves, continually dilating, expand, and throw off the scales which first appeared; and this centrifugal dilatation goes on till a sort of foundation is laid, which is incapable of growing in any direction except in breadth. Roots go on increasing under ground. Finally, a kind of base is formed, of a far

more considerable diameter than the future trunk, or stipes; which then shoots upwards, and increases regularly in dimensions, by the successive developement of leaves. These are enclosed, one within the other, in a peculiar manner, and constitute a bud of a particular description. Each has a tendency to rise to a fixed height above that which contained it; the old leaves, as they complete their functions, either fall off wholly, leaving only a scar behind, or partially, still continuing to clothe the stem with their remains. As soon as this stipes, or trunk, has acquired a certain elevation, bunches of flowers make their appearance in the axillæ. Sometimes they expand among the leaves, as in the date and cocoa nut; sometimes they appear from the stem, as in the areca nut. Although they do not appear till the trees have acquired maturity, they are formed long before. Traces of them may be discovered among the first leaves which are developed; but vegetation, powerfully attracted upwards by the summit, gives them no leisure to unfold themselves, till some check is given to the increase of the tree.

We have seen that a section of a dicotyledonous tree presents a series of concentric circles, which are, in fact, the register of its life. The scars or the scales of palms offer a similar, and not less certain, chronology of their past existence; and if you search the interior of their bud, or, as it is often named, their cabbage, which is one of the most delicate of foods, you will find that it is equally easy to read its future history. You will there find, without the aid of glasses, flowers and leaves already formed, which will not be finally produced till several years subsequently

For example, in a species of euterpe, found on the Island of Bourbon, the flowers are visible eight years before they are expanded. The summit is formed of twelve leaves, each supplied with a bunch of flowers in its axilla. These

leaves only expand each year, so that four years will have elapsed between the expansion of the first flowers and of the last, although even the former were discoverable four, and the latter eight, years previously.

Here, then, we have a mode of germination and developement very different from those of European plants. It is not, however, peculiar to palms; but is found, at least in an analogous manner, in a great number of the herbs which are natives of our latitudes. Only hot countries produce other trees with a similar peculiarity of organization. These differences have given rise to the establishment of two great divisions in the vegetable kingdom. Those plants of which we first treated are called dicotyledons, on account of the two lobes or cotyledons of their embryo; those which have been last under discussion are named monocotyledons, their embryo being provided with one cotyledon only.

If it were necessary to have recourse to an examination of the seed, whenever it was necessary to ascertain to which of these two great divisions a given plant belonged, few persons would be found who possess either the patience or opportunity required for ascertaining what is often a very minute point. But, fortunately, this division, which is founded in nature, possesses many external characters, which are quite as available as those of the seed. Before explaining them precisely, we will place two common plants under examination.

The first is the common onion. The seed of this plant, like the palm, but of much smaller dimensions, consists of an elongated simple embryo, placed in the midst of albumen. Its extremity, which is protruded by germination, becomes longer. One end becomes thickened, and buries itself in the soil, whence proceeds the root; the other end is elevated, and bears the seed, like a little cap. Present-

ly a green colour pervades it, and we can no longer doubt that it is a genuine leaf. A little above the root is a small lateral slit; from this a second leaf is produced, a third follows, and so on. Each is enclosed within the other, as in the palm; and, like it, they all direct their efforts to produce a kind of base; by these means the dilatation of the root takes place; and, the centre constantly forcing the interior outwards, a true onion is at last the consequence. The leaves, withering up as soon as they have performed their functions, perish, and leave behind them nothing but their fleshy sheaths, the most exterior of which wither and perish also; the interior retain their fleshy and swollen habit. As soon as the period of fructification has arrived, a simple leafless stipes is elevated from the centre of the root, and puts an end to the existence of the individual, except when buds exist among the leaves and give birth to what are called offsets.

The second example, which is equally familiar, shall be that of wheat. The valuable seed which is borne by this herb is, like that of the onion and the palm, formed of albumen, which is what we know under the name of flour, and of an embryo, which reposes at its base. The latter is a little different in figure from the two others; but, like them, it gives rise to a sheath, out of which in succession scales and then leaves arise. At the base of each sheath or leaf, in the inside, is found a bud, which is speedily developed, and contributes to form the tuft of herbage, under which appearance the plant is seen in its earlier stages. But, as soon as the flowering season arrives, a stem of a particular description is produced. Each leaf becomes separated from that which is next it by a considerable space; these spaces are hollow, and partitioned off by a particular kind of division. This kind of stem is called a culm. It is now obvious that there is something peculiar in the manner

of growth of the monocotyledons, which distinguishes them from dicotyledons. The leaves, however, offer marks of a more decisive kind. We have already seen that, in dicotyledonous plants, the nerves of the leaf resemble a sort of network, but in monocotyledons they have a parallel and rectilinear direction, passing without interruption from one end to the other; that is to say, those fibres which are nearest the principal rim run alongside it as far as the tip, where they are lost in the margin; and all the fibres affect the same direction. Hence the almost constant elongated form of their leaves, which are in some sorts comparable to the blade of a sword, being broadest at the base, and terminating in a point. You rarely can perceive the crenatures, or denticulations, or lobes, which are so common in the leaves of dicotyledons.

The flowers also offer some aid in distinguishing these two great classes from each other. The number of parts, which is so variable in most plants, appears almost fixed in monocotyledons. Every organ of fructification is arranged in a ternary mode, simple or double, or multiple. Dicotyledonous plants are much less constant; nevertheless, the number five, simple or multiple, is more commonly peculiar to them than any other number. It is extremely difficult to assign a cause for this peculiarity: perhaps it is to be sought in the manner in which the fibres first proceed from the parent embryo.

Having thus examined the progress of developement in the internal parts of a plant, and considered them with relation to their functions, we will conclude the subject of Vegetable Physiology by some remarks upon their variations. We have already seen, that the constituent parts of plants are, cellular tissue, woody fibre, and spiral vessels.

The *Cellular Tissue* consists of fine and membranous utricles. Individually, they resemble oblong bladders in-

flated in the middle, as in the case of some plants; or circular or hexagonal cells, as in the case of others. Collectively, they have been compared to an assemblage of threads of contiguous bladders or vesicles, or to the bubbles that are found on the surface of liquor in a state of fermentation.

But this description is applicable to them only as they occur in herbaceous plants; though in either case they are not always of the same figure, in all the different parts of the same plant. In the leaf-stalk of the artichoke, for example, their diversity of figure is very conspicuous, presenting, in their free and uncompressed state, whether on a horizontal or longitudinal slice, a beautiful assemblage of hexagonal cells; but in their crowded and condensed state, as they approximate the longitudinal fibres, an assemblage of tubular threads, successively inflated and contracted. In woody plants their diversity of figure is still greater, as must appear evident if it is but recollected that they constitute not only the bags or bladders of the cellular integument and pith, and of the pulp of the leaf and fruit, but also the very fabric of the divergent layers themselves; assuming a peculiarity of aspect, according to the degree of compression they sustain from other parts; or according to the degree of induration they may have undergone, ascending progressively, from the succulent texture of the pulp and pith to that of the firm and perfect wood.

The structure of the utricles of the tree is also said to be different from that of the utricles of the herb; the former being composed of a single membrane, and the latter of a double membrane. Senebier is, however, of opinion, that they consist of a double membrane in both cases, though not so conspicuous in the one case as in the other, owing to the more compact and condensed texture of the wood. However, they are all mutually connected with one another,

and also with the other vessels of the plant; which double union is rendered evident by means of coloured injections, or rather by means of the absorption of coloured infusions from which the utricles, as well as the longitudinal tubes, always receive a tinge. But in the petals, stamens, and pistils, they do not seem to be connected with the longitudinal vessels, as in the other parts of the plant; and perhaps they are also somewhat peculiar in their organization, as may be inferred from the following fact, namely, that the white and milky juice with which they are filled in the stem and branch of the fig does not ascend above the peduncle. In the pith they are generally larger than in any of the other parts of the plant; and in plants from which part of the trunk has been cut off, it has been remarked that they become altogether larger and more inflated than in plants of the same species that have not been so treated; which enlargement is perhaps to be accounted for from the superabundance of sap that now pervades them, in consequence of the diminished bulk of the vegetable. Senebier speaks of other utricles, distinct from those of the parenchyma, by which he means the pulp or pith, but without saying any thing explicit on the subject, and without representing them as different in form.

The *woody fibre* is made up of tubes of two kinds, which have been distributed into large tubes and small tubes. The large tubes are distinguishable by the superior width of the diameter which they present, on the horizontal section of the several parts of the plant.

In herbaceous plants they are represented, by M. Mirbel, as being always found in the centre of the longitudinal fibres; while in woody plants, they are often dispersed at random; though they occasionally form regular groups, which are sometimes concentric circles, constituting the principal mass of the ligneous layers. They are generally

to be found in great abundance surrounding the medullary canal. They are found also in the bark, and are capable of being traced from their origin in the extreme fibres of the root, to their termination in the extreme summit of the plant; uniting in the body of the root, traversing the collar, penetrating and ascending the stem in a parallel direction, separating and entering the branches, buds, and footstalks; separating again, and distributing themselves in smaller bundles, so as to form the nerves and veins of the leaves and petals, the slender fibres of the stamens and pistils, and the firm and woody fibres of the fruit. In the lichens, fuci, and fungi, no large tubes are discoverable, even with the aid of a microscope; though in the transverse section of most other plants they are visible without a microscope.

The simple tubes, which are the largest of all the large tubes, are formed of a thin and entire membrane, without any perceptible description of continuity, and are found chiefly in the bark, though not confined to it, as they are to be met with also both in the alburnum and matured wood, as well as in the fibres of herbaceous plants. But they are particularly conspicuous in the stem and other parts of the different species of euphorbia and periploca; and in all plants, in general, containing thick and resinous juices, known by the name of the proper juices, to the ready passage of which their great width of diameter is well adapted. Sometimes they are distinguishable by their colour, which is that of the juices contained in them, being white: as in euphorbia; or yellow, as in celandine; or scarlet, as in piscidia erythrina. In this plant they are united in bundles, but are detachable from one another by means of being steeped for a few days in spirit of turpentine, when they become altogether colourless and transparent, because the resinous matter which they contained

has been dissolved. Senebier says they retain their cylindrical form even in their detached state; and if so, the membrane of which they are composed must be very strong. The porous tubes resemble the simple tubes in their general aspect; but differ from them in being pierced with small holes, or pores, which are often distributed in regular and parallel rows. They are found in most abundance in woody plants, and particularly in wood that is firm and compact, like that of the oak; but they do not, like the simple tubes, seem destined to contain any oily or resinous juice.

The *spiral vessels* are fine transparent and threadlike substances, occasionally interspersed with other tubes of the plant; but distinguished from them by being twisted from right to left, or from left to right, in the form of a cork-screw. They occur in most abundance in herbaceous plants, particularly in aquatics; but they are also to be met with in woody plants, whether shrubs or trees. If the stalk of a plant of the liliaceous tribe, or a tender shoot of the elder, is taken and partly cut across, and then gently broken or twisted asunder, the spiral tubes may be seen with the naked eye, uncoiled somewhat, but remaining still entire, even after all the other parts have given way; and, if the inferior portion of the stalk is not very large, it may be kept suspended for some considerable time merely by the strength of the tubes, which though now almost entirely uncoiled, by means of the weight they support, will, when they finally break, suddenly wind up at each extremity, and again resume their spiral form.

Grew and Malpighi, who first discovered and described them, represented them as resembling in their appearance the trachea, or windpipe of animals, and designated them by the same term; an apellation by which they are still very generally known. Du Hamel endeavoured to convey

an idea of their form, by comparing it to that of a piece of riband rolled round a small cylinder, and then gently pulled off in the direction of its longitudinal axis. The figure of the riband becomes thus loosely spiral. This is a very good illustration of the figure of the spiral tubes in their uncoiled state, but it does not represent them very correctly as they exist in the plant. But the best illustration of this kind is perhaps that of Dr. Thomson's. Take a small cylinder of wood, and wrap round it a piece of fine and slender wire, so as that the successive rings may touch one another, and then pull out the cylinder. The wire, as it now stands, will represent the spiral tubes as they exist in the plant. And if it is stretched, by pulling out the two extremities, it will represent them in their uncoiled state also. But, although the spiral tubes are to be met with in almost all plants, they are not yet to be met with in all the different organs of the plant; or, at least, there are organs in which they occur but rarely, or in very small numbers.

They do not seem to occur often in the root; or, at least, they are not easily detected in it. Grew and Malpighi do indeed represent them as occurring often in the root, the former referring for examples to the roots of plants in general, and the latter to those of the asparagus, poplar, convolvulus, elm tree, and reed; "all of which," Keith says, "I have examined with great care, without being able to discover any spiral tubes. Senebier says he found them in the root of the balsams and thorn-apple; in examining which I was equally unsuccessful as in examining the former. I cannot, however, doubt the accuracy of the observations of the above phytologists, and can only set down my own want of success in discovery to the score of some defect, either in the specimens examined, or in my mode of examination. Indeed, the only root in which I have ever found them, after examining a very considera-

ble number, is that of the common garden lettuce, known by the name of cos lettuce. Having taken the root of a plant that was just putting out its flowers, and stripped it of its bark, I then cut it partly across, about the middle of its length, and broke the remainder of it gently asunder. On examining the surface of the fracture with the microscope, fragments of spiral tubes were seen projecting from it near the centre. They did not seem very tenacious of their spiral form; and when once uncoiled did not readily resume it."

The spiral threads are to be found also in the stem and branch, but not in all parts of them; or at least not in all periods of their growth. It seems very doubtful whether they exist at all in the bark. Daubenton professes, indeed, to have seen them in it, but no one else ever has; so that we are, perhaps, sufficiently well warranted in entertaining our doubts. It seems also very doubtful whether they exist in that part of the stem which consists of matured wood, though Daubenton professes to have seen them in the wood of cedrela; in which case he does not altogether stand alone; as they are represented both by Grew and Hedwig, as visible also in the wood. But they have not been found in the matured wood by any other vegetable anatomists. Du Hamel never met with them in any of the woody parts of woody plants, except in the young and herbaceous branches. Mirbel expresses himself to the same effect. And Mr. Knight, who has examined the subject perhaps still more recently, could not detect them in any of the permanent parts of such plants, except in the annual shoot. Keith's observations on this subject have had nearly a similar result. Among many subjects of examination he mentions only the elder, willow, hawthorn, cherry, and elm tree. In the three former he found them only in the annual shoot, situated immediately without the pith, or rath-

er imbedded in the alburnum; though in the elder some of them seemed to be imbedded even in the pith itself. In the cherry he found also a very few, similarly situated, in the branch of two years old; but none in wood older than that. And in the elm tree he has thought he had discovered them even in the matured wood. Having placed under the miscroscope a very thin slice, taken from a piece of the trunk of an elm tree, that had been felled at least six or seven years, he thought he was able to trace the remains of the spiral tubes. The slice was taken from the surface of a longitudinal section passing through the centre of the trunk, and clear of divergent layers; and the tubes seemed to appear most distinct when the slice was so placed as to present their longitudinal dimensions to the light. They seem to resemble ribands wrapped spirally round a cylinder, rather than to form separate vessels, which corresponds very well to their appearance, even in the succulent parts of many plants, as described by Knight. Some of them seemed even separate and entire. And yet, upon repeated observation, he has not been able to satisfy himself entirely on this point; but he has stated the case circumstantially, as being the probable means of inducing some one to take up the subject, who may be more felicitous in his investigations. It cannot be said to be a vain or fruitless inquiry; for as they are known to have existed at least in the tender shoot, it will follow that they must exist, in one shape or other, in the matured wood also. And if their spiral form is there obliterated, under what other aspect do they now appear? It seems certain, from the observations of Hedwig, that they assume a different figure in different stages of the plant's growth. In the peduncle of the colchicum autumnale, the rings of the tubes are closer when it begins to appear above ground, than at the time of flowering, from which he concludes that they are at length ex-

tirely obliterated, and the tubes converted into woody fibre. But sometimes it is difficult to detect them, even in the young shoot; though they are generally to be observed by breaking it gently asunder, and then examining the surface of the fracture with a microscope. In this case they appear in small fragments, projecting from the surface, and somewhat uncoiled; but if the shoot is split longitudinally, a portion of them will sometimes be found extended longitudinally on the surface of the fissure in an uncoiled state.

In the stem and branches of herbaceous plants, they are generally discoverable, without much difficulty, accompanying the longitudinal fibres, and forming part of the bundles. Keith has found them in the stem and branches of the burdock, even in winter, when the fragments of the mature plant had become quite indurated by means of their exposure to the weather.

They are also very easily detected in the footstalk, both of the leaf and flower, accompanying, or rather seeming almost entirely to compose, the bundles of longitudinal fibres. This may be well exemplified in the leaf-stalk of the artichoke, when young and fresh, in the fibres of which they are not only remarkably large and distinct, but also remarkably beautiful; some of them exhibiting in their natural position the appearance of spiral coats, investing interior fibres, rather than forming a distinct tube, and seeming when uncoiled to be themselves formed of a sort of net-like membrane.

They are discoverable also in the leaf, though not quite so easily detected as in the leaf-stalk. But if a leaf is taken, and gently torn asunder in a transverse direction, fragments of the spiral tubes will be seen projecting from the torn edges, and generally accompanying the nerves.

They are also to be found both in the calyx and corolla, but not so generally as in the leaf, on which account some

botanists have decided rather too hastily with regard to their nonexistence in these parts of the flower. Mirbel says, no tracheæ are to be found in the calyx nor in the corolla, except in the claw. But Keith has found them most unequivocally in the calyx of scabiosa arvensis, likewise in the expansion of the corolla of the same plant, as also in the calyx, both proper and common, of dipsacus sylvestris, and in the corolla of the honeysuckle, in which they appear to be placed within the nerves, or at least to be closely united to them.

In the other parts they do not seem to occur frequently, or at least it is difficult to detect them. Malpighi represents them, indeed, as occurring in the stamens, but Keith was not fortunate enough to meet with them in the stamens of any flower he examined. He looked for them also in the style of many flowers, and found them in that of the honeysuckle only.

According to the observations of Grew and Malpighi they are to be met with both in fruits and seeds; thoug Hedwig says they are not to be seen in the cotyledon except during the process of germination, and that only b means of their being moistened with some coloured infu sion. But Gærtner says they are conspicuous in the thin ner cotyledons, even before germination takes place; an Reishel is said to have detected them even in the plumel and radicle.

But, in whatever part of the plant they are found to ex ist, they are always endowed with a considerable degre of elasticity, as has been already noticed. For thoug they are forcibly extended, so as wholly to undo the spire they will again contract, and resume their former figur when the extending cause is withdrawn; and if they a even stretched till they break, the fragments will agai coil themselves up as before. It has been said, howev

that those of the butomus umbellatus, if once uncoiled, will contract again no more. But this is true only when they are stretched to a great length. For when they are stretched gently and moderately, they will again contract, as has been proved by experiment.

Malpighi, in the course of some observations on the spiral tubes during the winter season, fancied he had perceived a sort of vermicular and spontaneous movement in them. But he thought he saw this movement only once, and as it has never since been seen by any subsequent observer, it appears that we must be content to et it down to the score of microscopical deception, or to the effect of the atmosphere upon the tubes when exposed to its action.

We have now run over the differences of the most important kind, by which the functions of what Darwin not inaptly called the viviparous system of vegetation are affected. Let us now proceed to consider the nature and destination of the oviparous system, or of the parts of reproduction by seed. As the former depend upon internal organization, so do the latter upon external peculiarities.

Hitherto we have scarcely spoken of the flower; that brilliant ornament of plants, which attracts admiration by the splendour of its colours, and the delicacy of its texture, by the delicious perfume which it exhales, and by the wonderful mechanism with which it is constructed. Its base, which acts as an external envelope, is ordinarily of a green colour, and is called the calyx. The next envelope, which is the most striking, as it is in it that the beauty of the flower resides, is the corolla. Then succeed the stamens, which are generally delicate threads, terminated by a dilatation of a particular nature; and the pistillum, consisting of ovarium and stigma, which in time becomes the fruit. These parts generally exist all in a single flower,

which is then termed complete; if a part of the members is absent, the flower is termed incomplete. Each organ is susceptible of an infinite variety of combinations and modifications in form, in number, in station, in proportion, or in structure, which give rise to the smaller divisions of vegetables called genera. These will be noticed hereafter. The functions only of the organs are to occupy our attention while treating of Vegetable Physiology.

The most easy to observe is the corolla; which is composed of one or more pieces called petals; in the former state it is monopetalous, in the latter polypetalous. The petals are either equal or unequal in their form or insertion, whence corollas are either regular or irregular.

The stamens appear, from their position, to bear a direct relation to the corolla; thus, in almost all monopetalous flowers, they originate from the corolla itself; but in polypetalous flowers this more rarely happens: then, however, they maintain so many relations with the petals, being alternate or opposite to them, and equal or double or multiple in number, that it is impossible to doubt of the strict alliance by which they are connected. The calyx has a yet more strict analogy with the corolla, the divisions of which are almost always equal in number to those of the calyx, and alternate in insertion, especially when the corolla arises immediately from the calyx. It often happens that it arises from a particular place which is called the receptacle. These three parts, then, have a great analogy with each other; so that one does not vary in the number of its divisions, without affecting the two others by the change. They are themselves, however, subordinate to the pistillum.

There is generally only one pistillum in flowers; occasionally two or more: but these variations in number are independent of the other organs. The ovarium has then a more obvious relation: it is seated in the centre of the

flower, at the bottom of the calyx, to which it is attached by its base; sometimes a cohesion takes place between the sides of the calyx and ovarium, which latter then appears to support the flower like a footstalk. From these two modifications arise those two important distinctions among plants, of ovarium superius, or separate from the calyx, and ovarium inferius, or adhering to the calyx; differences which are of extreme importance in characterizing many of the most natural of the systematic combinations of modern botanists.

In some flowers the corolla disappears, or is not developed; in others the calyx seems to be wanting. A disquisition has arisen, touching this fact, as to what name ought to be applied to the envelope of a flower when one envelope only is present. By whatever name this single envelope may be called, it bears the same relation to the other parts as the calyx and corolla when both are present; it is in some cases itself almost obliterated, and there are some flowers which consist only of stamens without corolla, and which are then called naked.

When both calyx and corolla exist together, or one of them only, another set of organs occasionally disappears, namely the stamens, and then the pistillum is found alone in the centre; but in this case it always happens that, either upon the same plant or upon a different individual, flowers exist which contain stamens only, and no pistillum. Sometimes both organs are developed without covering, and separate from each other. However these two parts may be separated from each other, they always appear at the same period of time, and no instance has been found of a perfect plant in which both organs do not coexist.

It appears, therefore, that the stamens and the pistil are the only essential parts of a flower; a fact which is not surprising as far as the pistil is concerned, because we have

seen that it contains the rudiments of the future progeny. But what manner of influence is exercised by the stamens? If we examine them, we shall find that they have a similar structure: we shall see that they consist of two parts, the upper resembling a little bag, generally yellow, and always divided into one or two cells, which contain a kind of powder, and the lower resembling a threadlike stalk to the former. The former is called the anther, and the latter the filament. The powder which it contains, examined through a microscope, consists of granules, varying in size and form according to their species, and sometimes so remarkably that it is often possible to distinguish genera by the inspection of the granules only. Thrown into water they swell, and eventually burst, emitting a peculiar fluid which resembles vapour. The name given to the granules is pollen.

From the combination of these observations, we come to an important discovery; we perceive that the petals, with the brilliant tints of every colour in the rainbow, are in fact the curtains of the nuptial bed of Flora, within the protection of which the mysteries of generation are accomplished. We have, therefore, sexes in plants; these, indeed, appear almost indispensable. In most animals they are separated; but in vermes we see them confounded, and at length disappear entirely. The want of the power of motion in vegetables renders their union in one individual of great importance. But, as if the resources of nature were illimitable, they are in some cases separated upon the same tree, or upon different trees, and the agency of the wind or of insects is requisite to enable them to accomplish their destiny.

The relation, therefore, of the stamens to the pistillum gives rise to some further considerations. When they are united in one flower, the flower in that case is called hermaphrodite; if they are in separate flowers, it is declin-

ous; it is monœcious when the male and female are present in different flowers of the same individual; diœcious if in flowers of different individuals. Some plants have male and female flowers mixed with such as are hermaphrodites; then they are called polygamous.

The pistillum offers a multitude of most important characters. Its ovary is terminated by one or several styles, and each of the latter has one or more stigmata. The ovarium either contains only one rudiment of a seed, called an ovulum, or several, and is divided internally into one cell or many.

The fruit, which is the necessary consequence of the ovarium, is generally like it in the number of its parts; the occasional abortion of some one of the latter is the only way in which the number of parts is smaller in the fruit than in the ovarium. The form, the texture, and the volume of fruit, give rise to an infinity of differences. Thus one sees, on the one hand, soft pulpy fruit, and, on the other hand, nuts, the shell of which is hard as wood itself. The manner in which the seeds are attached is also subject to variation, for they either proceed from a central receptacle, or from the paries of the fruit. The point from which they proceed is, in all cases, called the placenta. This organ is of great importance; for it is not only the medium through which the fecundating effluvia of the pollen is communicated to the ovula, but also through which the juices are elaborated, which are required for the developement of the embryo. It may be compared to the placenta of animals.

The position of the embryo, with relation to the fruit, is also a point of importance. Thus the axis of the seed may be parallel with the axis of the fruit, and fixed by the basis, which is the most natural position; then the seed is called erect. It may become horizontal; or, being affixed to the

summit of the cell, it may become inverted; it is in the latter case said to be pendulous. For various modifications of the position of the seed, see SEED, under PURE BOTANY.

Each seed may be considered as an insulated individual; for nature has prepared them for separation from their parent without inconvenience. Their interior consists of a substance of various degrees of texture, which is called the albumen, and of the fleshy body already mentioned as the seminal embryo. The albumen may be absent, the embryo must be present. The coat of the seed consists of two layers the interior of which is much more membranous than the exterior.

But now arises a problem in vegetation which it is very important to resolve. Whence is the origin of the flower? Linnæus has offered an explanation, which he considered capable of meeting every difficulty, and which he borrowed from Cæsalpinus. According to these two authors, the flower is only a manifestation of the interior of a plant. The epidermis and cuticle give rise to the calyx, the fibre to the corolla, the woody fibre to the stamen, and the pith to the pistillum. This last part is the most essential, and the centre of vegetation; the others are only accessory.

But this ingenious notion will not bear a strict scrutiny. The nature of the pith is now better understood; and, instead of being a creating organ, it is itself, in fact, a body in a state of disorganization. A single fact has overthrown the whole theory: this is the more intimate knowledge of the interior of palms, and other monocotyledonous trees. According to the arrangement of their interior, and the mixture of the pith and woody fibre, it would happen, if Linnæus's theory were true, that the flowers of the palm would have quite another arrangement from that of other plants, and that the parts would neither be arranged round a centre, nor be placed in the same relation to each other.

It appears certain that, notwithstanding the striking differences which all parts of a flower exhibit, they have all the same origin; which is indicated by the propensity they all have, under certain circumstances, of changing into each other from circumference to centre, or of reverting to one common appearance; which is that of the leaf. It may thence be concluded that a flower is a leaf-bud in a particular state of alteration; that the calycine lobes, the petals, the stamens, the pistillum, are all leaves in an altered form, and that they have all a tendency, which may now and then manifest itself, of assuming their primitive habit and structure.

The pistillum, which is the terminating point of the line of vegetation, is now ascertained to be, not, as was formerly supposed, an anomalous organ, which was referrible to none of the simple types upon which the other parts of fructification are modelled, but a leaf or leaves also in a state of greater affinity to their type than any other organ. The style is an alteration of the middle nerve, the stigma a secreting surface proceeding from the tip of the same part, the sides of the ovarium the two halves of the leaf, aud the placenta the edges of the leaf. This is tolerably obvious in a strictly simple unilocular ovarium, such as one segment of a Pæony fruit. But in a many-celled pistil it is not so apparent. Mr. Robert Brown, however, has demonstrated that all multilocular compound ovaria are merely an aggregation of a number of simple ovaria round a common axis; that the cells are occasioned by the interposition and cohesion of the sides of simple ovaria, which in that state are called dissepiments.

Besides the plants which are furnished with a flower, there are others in which no apparent flowers exist, which are constructed differently from either monocotyledonous r dicotyledonous plants, and whose methods of reproduc-

tion are quite of another nature. These plants are called cryptogamous, and consist of ferns, mosses, hepaticæ, lichens, algæ, and fungi. They are all supposed to be destitute of cotyledons, whence they are also named acotyledonous.

In ferns, which are by some authors referred to monocotyledons, the mode of growth resembles in some measure such plants. The grain from which they are reproduced, and which is called a sporule, in germination dilates into a very small leaf of a particular kind, which successively gives rise to others, which finally acquire the stature and the form of adult leaves. A species of trunk or stipes, similar to that of the palm, creeps along the surface of the earth, or elevates itself above it. Its internal structure separates it as far from monocotyledons as from dicotyledons. It has, however, at the first sight, the greatest resemblance to the former; a section of it offers, as in monocotyledons, certain scattered points, among a mass of parenchyma. These points, which vary in almost every different species, are a section of a peculiar substance, which is divided at the base, and united at the summit, and which may be compared in texture to the liber of dicotyledons. It is surrounded by a fur, which is more or less apparent, and more or less deeply coloured, and which seems analogous to the woody texture, especially as in arborescent ferns it is it which forms the solid substance. Both these substances are distributed among the nerves of the leaves, which are simple, ramified, or verticillated, according to the species. In the opinion of a celebrated modern physiologist, a fern may be considered as a plant turned inside out.

The remaining classes of cryptogamia consist entirely of cellular tissue, amassed in different proportions, and under various forms. They are destitute of woody vessels or of tracheæ, and have no distinction between bark, wood, and epidermis; they may perhaps be considered to consist wholly of the latter and former confounded.

PURE BOTANY.

We have thus considered botany with respect to its analogies and its physiology. It now remains for us to explain its practical details, as applied to what is called Systematic Botany, or the science of arranging the natural objects of which it consists.

The materials of this branch of the science are the modifications of parts; from a just application of these materials result classifications. We shall first attend to modifications.

All perfect plants consist, as has been already seen, of the following organs. 1. The Root; 2. the Stem; 3. the Foliage; 4. the Inflorescence; 5. the Flower; 6. the Fruit. Each of these organs must be considered separately. But, before entering upon an explanation of the peculiarities of each of them, it will be proper to notice the terms used in speaking of their size, surface, and colour; these terms being applicable to each of the six parts into which a plant is divisible.

They are eleven terms which are employed to designate the size or measurement of a plant or its parts, viz.

1. A hair breadth (capillus), the measure of a hair, or the twelfth part of a line.—2. A line (linea), the length of the white crescent at the root of the nail of the middle finger, or the twelfth part of an inch.—3. A nail length (unguis), the length of the nail of the middle finger, or half an inch.—4. An inch (pollex, uncia), the length of the first joint of the thumb, the twelfth part of a foot.—5. A hand breadth (palmus), the breadth of the four fingers of the hand, or three inches.—6. A span (dodrans), as far as one can span with the thumb and the little finger, or nine inches.—7. A small span (spithama), as far as one can span with the thumb and fore finger, or seven inches.—8. A foot (pes)'

the length from the elbow to the wrist, or twelve inches.—9. A cubit (cubitus), from the elbow to the point of the middle finger, or seventeen inches.—10. An ell (ulna, brachium), the length of the whole arm, or four-and-twenty inches.—11. A fathom or toise (orgya), the length of the arms stretched out from the tip of one middle finger to that of the other, or six feet.

For these the following have been substituted by some French botanists:—

The millimètre = $\frac{441}{1000}$ of a line.—The centimètre = 4 lines $\frac{422}{1000}$.—The decimètre = 3 inches 8 lines $\frac{320}{1000}$.—The mètre = 3 feet 11 lines $\frac{206}{1000}$.

The surface of plants is of great importance in distinguishing the species and varieties, but it is not of value in generic discrimination. The terms which follow are, or ought to be, used precisely in the sense here ascribed to them; they are extremely well defined by Willdenow, who limits them thus:—

1. *Shining* (nitidus), when the surface is so smooth that it reflects the rays of light, and has a shining or glancing appearance, as in the leaves of the holly, Ilex aquifolium.—2. *Dull* (opacus), when the surface does not reflect the rays, and is entirely void of lustre.—3. *Even* (lævis), without striæ, furrows, or raised dots. It is the opposite of Nos. 6, 7, 23, 24, 25, 28, and 29.—4. *Smooth* (glaber), when there are no visible hairs, bristles, or thorns. It is the opposite of Nos. 8, 22, 26, and 27.—5. *Dotted* (punctatus), when small fine dots are perceived by the eye but not by the touch. Thymus vulgaris.—6. *Scabrous* (scaber), when small raised dots are felt but not seen; as in Carex acuta.—7. *Rough* (asper), when these dots are both felt and seen. Pulmonaria officinalis.—8. *Hispid* (hispidus), beset with very short stiff hairs. Myosotis arvensis.—9. *Hirsute* (hirtus), when the hairs are moderately

long, but very stiff. Echium vulgare.—10. *Hairy* (pilosus), beset with long single hairs, somewhat bent. Hieracium pilosella.—11. *Villous* (villosus), when the hairs are long, soft, and white. Stachys Germanica.—12. *Pubescent* (pubescens), overgrown with short fine white hairs. Oenothera molissima.—13. *Silky* (sericus), when the surface is white and shining, by means of thick and almost invisible hairs. Potentilla anserina.—14. *Woolly* (lanatus), when the surface is beset with long thick white hairs, easily distinguished. Stachys lanata.—15. *Tomentose* (tomentosus), when fine hairs are so matted together that the particular hairs cannot be distinguished. In this case the surface generally appears white, as in Verbascum; or of a rust colour, as in Ledum.—16. *Bearded* (barbatus), when the hairs are in tufts. Mesembryanthemum barbatum.—17. *Strigose* (strigosus), when the surface is armed with small, close-lying bristles, which are thickest below. Lithospermum officinale.—18. *Stinging* (urens), when a painful burning sensation is caused by small hairs. Urtica. Such hairs are called stimuli.—19. *Fringed* (ciliatus), when on the margin of a leaf, or the surface of a stalk, there is a row of hairs of equal length.—20. *Warty* (papillosus), when small fleshy warts appear. Aloe margaritifera.—21. *Pustular* (papulosus), when there are small hollow bladders. Mesembryanthemum hispidum.—22. *Muricated* (muricatus), armed with small short herbaceous spines. Asperugo procumbens.—23. *Scaly* (lepidotus), when the surface is covered with small scales closely placed, by which means the colour is changed, as in Elæagnus angustifolia.—24. *Mealy* (farinosus), when the surface is thickly covered with a white powder, as in Primula farinosa.—25. *Hoary* (pruinosus), when the surface is strewed with very fine white dust, like the fruit of some plums. Prunus domestica.—26. *Glutinous* (glutinosus), when the

surface is covered with an adhesive matter, which is soluble in water. Primula glutinosa.—27. *Viscid* (viscidus), when the surface is covered with a viscid juice, which is resinous or greasy. Cerastium viscosum.—28. *Striated* (striatus), when the surface is finely streaked. Aira cæspitosa.—29. *Furrowed* (sulcatus), when the streaks form small furrows. Umbellæ.

The following are the principal COLOURS, which are distinguished by name: this part of the subject is extremely imperfect; and perhaps from its nature will always, like all distinctions depending upon so uncertain a power as that of discriminating between the delicate gradations of so unmanageable an agent as of light, remain in an imperfect state. The Latin names are necessarily employed from the want of equivalent expressions in the English language.

1. *Cyaneus;* dark blue, like Prussian blue.—2. *Cæruleus*; sky blue, like the flowers of Veronica Chamædrys.—3. *Azureus;* nearly the same as No. 2, but bright like ultramarine.—4. *Cæsius;* pale blue, verging towards gray.—5. *Atrovirens;* dark green, bordering upon dark blue.—6. *Æruginosus;* light bluish green, like verdigris.—7. *Prasinus;* saturatè virens, smaragdinus; grass green, without any tinge of yellow or blue.—8. *Flavo-virens;* green, bordering upon yellow.—9. *Glaucus;* green, bordering upon gray.—10. *Aureus;* golden yellow, without any foreign mixture.—11. *Ochraceus;* yellow, with a slight tinge of brown.—12. *Pallidè flavens;* pale or whitish yellow.—13. *Sulphureus;* bright yellow, like the flowers of the Hieracium Pilosella.—14. *Vitellinus;* yellow, with a slight tinge of red.—15. *Ferrugineous;* brown, verging towards yellow.—16. *Brunneus;* the darkest pure brown.—17. *Fuscus;* brown, running into gray.—18. *Badius; Hepaticus;* chestnut or liver brown, bordering on dark red.—19. *Aurantia-*

cus; orange, or a mixture of yellow and red.—20. *Miniatus*, or *Cinnabarinus*; deep red, like red lead.—21. *Lateritius*; brick colour, like the former, but duller, and verging towards yellow.—22. *Coccineus*, or *Phœniceus*; cinnabar colour, with a slight tinge of blue.—23. *Carneus*; flesh colour, something between white and red.—24. *Croceus*; saffron colour, dark orange.—25. *Puniceus*; fine bright red, like carmine.—26. *Sanguineus*, or *purpureus*; pure red, but duller than the foregoing.—27. *Roseus*; rose colour, a pale blood red.—28. *Atropurpureus*; very dark red, almost approaching to black.—29. *Violaceus*; violet colour, a mixture of blue and red.—30. *Lilacinus*; lilac, the former colour; but duller, and verging towards red.—31. *Ater*; the purest and deepest black.—32. *Niger*; black, with a tinge of gray.—33. *Cinereus*; ash colour, blackish gray.—34. *Griseus*; lively light gray.—35. *Canus*; hoary, with more white than gray.—36. *Lividus*; dark gray, running into violet.—37. *Lacteus*, or *Candidus*; shining white.—38. *Albus*; dull white.—39. *Albidus*; dirty dull white.—40. *Hyalinus*; transparent, like pure glass.

The Root is divided by botanists into four principal forms, viz. the *Rhizoma*, or Rootstock, by which is meant the thick fleshy part of the biennial or perennial root; the *Fibre*, or those parts of the root which have the appearance of threads; the *Tuber*, which is a solid fleshy root, furnished with buds on its surface, and being in fact a thickened subterraneous stem; and the *Bulb*, which consists only of fleshy imbricated scales, as in the onion. Each of these is subject to a great variety of appearances.

1. *The Rhizoma is*,

1. *Woody* (lignosum), composed of a woody substance and numerous woody fibres; such as that of trees and

shrubs.—2. *Fleshy* (carnosum), consisting of a fleshy substance more or less firm; as Daucus Carota, Pastinaca Sativa.—3. *Hollow* (cavum), that is always hollow in the middle, as Fumaria Bulbosa.—4. *Partitioned* (loculosum), an oblong root, internally furnished with separated cavities; as Cicuta Virosa.—5. *Entire* (integrum), never naturally internally hollow, and thus the opposite of the two last mentioned.—6. *Cylindrical* (cylindraceum), that comes nearest to a cylindrical figure, and is thick; as Dictamnus albus.—7. *Spindle-shaped* (fusiforme), cylindrical above, and tapering to a point as it descends; as in Daucus carota, Pastinaca sativa.—8. *Bitten* (præmorsum), where the principal root seems as if it were bitten off, as Scabiosa succisa, Plantago major.—9. *Wormlike* (vermicularis), thick and almost cylindrical, but bent in different places; Polygonum Bistorta.----10. *Turnip-shaped* (napiforme), bellying out above, but below ending in a long taper point, Brassica Napa.—11. *Roundish* (subrotundum, or globosum), that is almost spherical, as Raphanus sativus, Bunium Bulbocastanum.—12. *Flat* (placentiforme), a thick round root, which above and below is compressed, so that it almost resembles a plate; Cyclamen.—13. *Jointed* (geniculatum), divided into members, from which the root-fibres proceed; Gratiola officinalis.—14. *Scaly* (squamosum), covered with more or fewer fleshy scales; Lathræa squamaria.—15. *Toothed* (dentatus), a fleshy branched root, having teeth-like prolongations; Corallorhiza innata.—16. *Tufted* (commosum), having as it were tufts of hair at its points, which are the fragments of the petioles, divided like fibres; Æthusa Meum.—17. *Many headed* (multiceps), divided at top into numerous branches, from which new shoots spring; as Astragalus, Geranium macrorhizon.—18. *Simple* (simplex), having no branches.—19. *Branching* (ramosum), dividing into branches, as all trees, shrubs, and many

plants.—20. *Perpendicular* (perpendicularis), going straight down into the earth; Capsella bursa pastoris.—21. *Horizontal* (horizontale), running horizontally under ground into the earth, but obliquely, as Æthusa meum.—22. *Oblique* (obliquum), going neither perpendicularly nor horizontally into the earth, but obliquely; as Æthusa meum.—23. *Creeping* (repens), lying horizontally under the earth, and extending itself in that direction by means of side-branches; as Rumex Acetosella.—24. *Ringed* (annulatum), furnished on its upper surface with alternately raised and depressed bands.—25. *Knobbed* (tuberculatum), furnished on its upper surface with protuberances; as Æthusa, meum, Bunium bulbocastanum.—26. *Scarred* (cicatrisatum), which, upon the perishing of the stem, has depressions or chinks on its upper surface; as Polypodium vulgare.—27. *Chaffy* (paleaceum), covered with membranaceous scales; as many of the filices.—28. *Even* (læve), marked on its surface neither with elevations nor depressions.

2. *The Fibre is,*

29. *Threadlike* (filiformis), consisting of a single fibre. —30. *Fibrous* (fibrosa), consisting of many fibrous roots; as Poa annua.—31. *Hairlike* (capillaris), consisting of numerous very fine fibres; as Scirpus acicularis.—32. *Velvetlike* (veluntina), composed of very tender and hardly visible fibres; as in the Musci frondosi.—33. *Cleft* (fissa), very short, and at the point dividing into two or three points; Peltidea canina.

3. *The Tuber is,*

34. *Knobbed* (granulatum), the knobs formed like small grains of corn; as Saxifraga granulata.—35. *Testiculated* (testiculatum), when two, rarely three, longish depressed knobs hang from the point from which a shoot rises; as in

Orchis.—36. *Palmated* (palmatum), when two, rarely three longish depressed knobs, which are divided at the point hang together; as in the last, Orchis.—37. *Fingered* (digitatum), when a single fleshy knob is compressed and divided at the point like fingers; Dioscorea alternifolia.—38. *Bundled* (fasciculatum), when many cylindrical or longish roots hang together from the point, so as to resemble a bundle; Ranunculus Ficaria, Epipactis Nidus avis.—39. *Globulated* (conglobatum), when several round knobs sit upon one another; as Helianthus tuberosus.—40. *Depending* (pendulum), when several knobs hang together from fibrous roots; as Solanum tuberosum, Spiræa Filipendula.—41. *Articulated* (articulatum), when one knob grows out of another, so that the whole seems to consist of connected members.—42. *Necklacelike* (moniliforme), when many knobs hang together by a fibrous root, in rows as if they were strung on; as Pelargonium triste.

4. *The Bulb is,*

43. *Imbricated* (imbricatus, squamosus), when the bulb consists of leaves lying over one another, like the tiles of a house; as Lilium bulbiferum.—44. *Coated* (tunicatus), when the bulb is composed of concentric layers; as in Allium.—45. *Netlike* (reticulatus), when the bulb is entirely composed of reticulated membranes; as Allium Victorialis.—46. *Half netlike* (semireticulatus), when the bulb consists of a firm mass, but the outer membrane is netlike; as Gladiolis communis.—47. *Solid* (solidus), when the bulb consists of a firm substance throughout; as Colchicum autumnale.—48. *Nestling* (nidulans), when small bulbs appear under the external membrane, and the bulb seems to be entirely composed of them; as in Ornithogalum spathaceum.—49. *Aggregated* (compositus, aggregatus), when several bulbs stand close together, having a connection at

the base.—50. *Two-fold* (geminatus), when two bulbs are connected by their base; as Fritillaria pyrenaica, Erythronium dens canis.—51. *Doubled* (duplicatus), when one bulb stands above another, and grows out of it; as Allium sphærocephalon.—52. *Supported* (suffultus), when the body of the root stands at a distance, equalling it in size, and distinctly separated from it; as Ixia punicea, erecta.—53. *Single* (solitarius), when neither from the side nor from the base proceeds another bulb.—54. *Central* (centralis), when the shoot proceeds from the middle, as Galanthus nivalis. —55. *Lateral* (lateralis), when the shoot issues from the side; as in Ixia virgata.

Besides the above there are a few roots which being referrible to none of the foregoing, are called nothous, or

Anomalous.

56. *Divided* (divisa), that branches out above stones or other bodies, but does not penetrate into the earth; as Fucus digitatus.—57. *Byssuslike* (byssacea), that is divided like wool, and has the appearance of a filamentary byssus; as many species of Agaricus.—58. *Warty* (papillosa), consisting of short wartlike small dots, by which the plant attaches itself to wood or stones; as Lichen.—59. *Shieldlike* (scutiformis), when the base of the ascending stem spreads itself into a thin surface, by which the plant is attached to wood or stones; as Usnea florida, Ceramium filum.—60. *Fading* (evanescens), when the descending stem penetrates into wood and therein gradually disappears; as Viscum album.

The Stem is the prolongation of the plant above the soil, or above the part which serves for its support. It is subject to great diversity of forms, and the number of terms used to distinguish their varieties are numerous.

The STOCK (cormus) is that part of the plant whi serves for the support of the whole, and bears the infl rescence, the leaves, the frond, the flowers, and fru from it are evolved in most cases all these parts. T following kinds have been distinguished: viz. the ste (caudex), the trunk (truncus), the stalk (caulis), the str (culmus), the scape (scapus), the stipe (stipes), the sho (surculus), the sarment (sarmentum), and the suck (stolo).

The STEM (caudex) is a simple perennial shoot, wi leaves at its extremity, and is peculiar only to the palr and arboreous filices, having no bark, but set round wi the remains of the leaf-stalks. Of this there are the f lowing kinds:—

1. *Ringed* (annulatus), when the remains of the leav at regular distances resemble annular elevations; as Cor pha rotundifolia.—2. *Scaly* (squamosus), when the remai of the leaves surround the stem irregularly; as in Phœn dactylifera, Chamærops humilis.—3. *Tessellated* (tessel tus), when the leaf or the base of the stipe does not r main behind, but leaves a scar, by which the stem puts a tessellated appearance; as Polypodium arboreum.— *Aculeated* (aculeatus), when the remains of the leaf are with prickles; as in Cocos aculeatus, Polypodium asp rum.—5. *Smooth* (inermis), the opposite of the last, wh the remains of the leaf leave no prickles, as Phœnix dact lifera, Polypodium arboreum.

The TRUNK (truncus), is peculiar to trees and shru and is perennial. The principal stem in these plants h obtained the following denominations: its principal di sions are called branches (rami), and its subdivisions twi (ramuli).

1. *Treelike* (arboreus); this is simple, and forms at t a crowd or crown of branches (cacumen); it is peculiar

trees.—2. *Shrubby* (fruticosus), divided below into a number of branches, like all shrubs.

The Stalk (caulis), is herbaceous, seldom woody, and lasts but one or two years; hence it is proper only to herbaceous plants, however, the term is sometimes applied both to trees and shrubs. The divisions of this are also called branches (rami). The kinds are,

In respect of Division.

1. *Very simple* (simplicissimus), that has no branches, nor is its flower-stalk divided, consequently it can have but one flower or spike, and no flowers in the axillæ of the branches.—2. *Simple* (simplex), having no branches, but whose flower-stalk may be divided.—3. *Somewhat branched* (subramosus), sometimes without branches, sometimes with one or two.—4. *Branched* (ramosus), which is always furnished with branches.—5. *Much branched* (ramosissimus), where all the branches are not only divided but subdivided.—6. *Disappearing* (deliquescens), branched, but so divided that the principal stem is no longer to be observed, but is lost in the ramification.—7. *Entire* (integer), which is branched, but where the principal stem can be traced to the point.—8. *Verticillated* (verticillatus), when a number of branches are formed at the extremity, from the centre of which the principal stem proceeds, so that the branches, at certain distances, surround the stem in a circular manner: as in Pinus sylvestris.—9. *Proliferous* (prolifer), when the stem is divided into a number of branches, and these again likewise divide, but the principal stem does not proceed from the centre of them; as Ledum palustre.—10. *Dichotomous* (dichotomus), when the stem, even to the smallest branches, divides itself into two; as Viscum album.

In respect of the branches.

11. *Alternate branches* (rami alterni), the branches are s placed that between two on the one side there rises bu one on the opposite side.—12. *Opposite branches* (rami op positi), when one branch stands on the opposite side t another, and the bases of each nearly meet together.—1 *Distichous* (distichus), when the branches, being opposit to each other, stand on the same plane.—14. *Scatter* (sparsus), when the branches stand without order on th stem.—15. *Close* (confertus), when the branches stand thick and without order that no space remains between the —16. *Brachiate* (brachiatus), when opposite branches stan at right angles to each other, or crossways.—17. *Rodli* (virgatus), when the branches are very long, weak, an thin.—18. *Panicled* (paniculatus), when a stem at its poi is divided into numerous leaves and flower-beari branches; as Rumex acetosella.—19. *Fastigiate* (fastigi tus), when all the branches from bottom to top are of su different lengths that they are of equal height.—20. *Co pact* (coarctatus), when the tips of the branches are be inwards towards the stem.—21. *Spreading* (patens), wh the branches stand nearly at right angles with the stem 22. *Diverging* (divergens), when the branches form a rig angle.—23. *Divaricated* (divaricatus), when the branch are so situated that they form an obtuse angle above, a an acute angle below.—24. *Deflected* (deflexus), the branch hang down forming an arch.—25. *Reflected* (reflexu when the branches hang so much down that they alm run parallel with the stem.—26. *Retroflected* (retroflexu when the branches are bent towards every side.

In respect of strength.

27. *Stiff* (rigidus), that will not bend without breaking 28. *Brittle* (fragilis), that breaks with the smallest force

). *Flexible* (flexilis), that can be bent in any direction ithout breaking.—30. *Tough* (tenax), that can be bent ithout breaking, and can be with difficulty torn.—31. *Lax* ıxus), that is firm, but moves with the smallest breath of ind.—32. *Parasitical* (parasiticus), that fixes itself by its ot on the root or wood of other plants; as Viscum onotropa.—33. *Erect* (erectus), when the stem stands arly perpendicular.—34. *Straight* (strictus), where the em is perpendicular, and quite straight.—35. *Weak* (de-lis), when the stem is too slender to maintain itself per-ctly upright.—36. *Bent upwards* (adscendens), when the em lies on the ground, but the extremity of it stands erect. 37. *Bent downwards* (declinatus), when the stem is so ent downwards to the earth that it forms an arch.—38. *upported* (fulcratus), that from above sends roots down to the earth, which afterwards change into real stems; in the Rhizophora.—39. *Stooping* (cernuus), when the int in an upright stem takes a horizontal direction.—40. *odding* (nutans), when the point is bent down towards e horizon.—41. *Pendulous* (pendulus), when a parasitical ant (No. 32) has its base turned towards the zenith, and top towards the earth.—42. *Procumbent* (procumbens, ostratus, humifusus), when the stem lies flat on the ound.—43. *Decumbent* (decumbens), when the stem is pright below, but above is bent down towards the ground, that the greater part of it is bent.—44. *Creeping* (re-ens), when the stem lies along, and sends out roots from elow.—45. *Sarmentose* (sarmentosus), when the stem lies ong, but sends out roots only at certain intervals.—46. *ooting* (radicans), when the stem stands upright and imbs, every where sending forth small roots, by which it olds itself fast; as in the ivy. Hedera helix.—47. *Swim-ing* (natans), lying on the surface of water; as Polygo-um amphibium.—48. *Sunk* (demersum), that lies below

the surface; as Ceratophyllum demersum, Utricularia.—49. *Flexuose* (flexuosus), when the upright stem bends itself in a zig-zag manner, so as to form a number of obtu angles.—50. *Climbing* (scandens), a weak stem that faste itself to some other body for support; as the passion-flowe Passiflora cærulea.—51. *Twining* (volubilis), a weak ste that twines in a serpentine form round other plants; it of two kinds.—*a. Turning from the right* (dextrorsu when the stem twines from the right to the left round supporting body; as in the bind-weed, Convolvulus.—*Twining from the left* (sinistrorsum), when the stem twi from the left to the right round a supporting body; as the hop, Humulus Lupulus.

In respect of clothing.

52. *Naked* (nudus), having no leaves, scales, or the li —53. *Leafless* (aphyllous), without leaves only.—54. *S ly* (squamosus), covered with scales.---55. *Ramentac* (ramentaceus), that is covered with dry membranous scal as Erica ramentacea.—56. *Stipulate* (stipulatus), furni with stipulæ in the axillæ of the leaves; as Vicia sativ 57. *Exstipulate* (exstipulatus), without stipulæ.—58. *L* (foliosus), having leaves.—59. *Perfoliate* (perfoliatus), wh the stem goes through a leaf; as Bupleurum.—60. *Wi ed* (alatus), when a leaf-like membrane runs along th stem.—61. *Bulb-bearing* (bulbifer), having bulbs or tube cles in the axillæ of the leaves; as Lilium bulbiferum, Den taria bulbifera.---62. *Prickly* (aculeatus), when along th stem there are pointed protuberances coming off with th rind.---63. *Spiny* (spinosus), when there are pointed pro berances on the stem which do not come off with the ri ---64. *Smooth* (inermis), having neither prickles nor spi ---65. *Barren* (sterilis), bearing no flowers.---66. *Fru* (fructificans), bearing flowers or fruit.

In respect of figure.

67. *Round* (teres), that is, quite cylindrical.---68. *Half-round* (semiteres), that is, round on the one side and flat on the other.---69. *Compressed* (compressus), when the stem is flat on both sides.---70. *Two-edged* (anceps), when a compressed stem is sharp on both edges.---71. *Angled* (angulatus), when a stem has several angles, but the sides are grooved. Of this there are several kinds, viz. α. *Obtuse-angled* (obtuse angulatus). β. *Acute-angled* (acute angulatus). γ. *Three-angled* (triangularis). δ. *Four-angled* (quadrangularis), &c. ε. *Many-angled* (multangularis).---72. *Three-sided* (triqueter), when there are three sharp corners and the sides quite flat.---73. *Three-cornered* (trigonus), when there are three round or obtuse edges, but the sides appear flat. Of this too there are several kinds: α. *Four-cornered* (tetragonus). β. *Five-cornered* (pentagonus). γ. *Six-cornered* (hexagonus). δ. *Many-cornered* (polygonus).---74. *Membranaceous* (membranaceus), when the stem is compressed and thin like a leaf.---75. *Knotted* (nodosus), when the stem is divided by knobs.---76. *Knotless* (enodis), when it has neither knobs nor joints.---77. *Articulated* (articulatus), when the stem has regular knobs at the joints, as in Cactus.—78. *Jointed* (geniculatus), when a stem has regular knobs, not seated on the joints.

In respect of substance.

79. *Woody* (lignosus), that consists of firm wood.—80. *Fibrous* (fibrosus), that consists of woody fibres, that can be easily separated.—81. *Herbaceous* (herbaceus), that is weak and can be easily cut.—82. *Fleshy* (carnosus), that is nearly as juicy and soft as the flesh of an apple.—83. *Firm* (solidus), internally hard.—84. *Empty* (inanis), filled internally with a soft pith.—85. *Hollow* (fistulosus), without any pith within and quite hollow.—86. *With separations*

(septatus), where either the pith or the hollow space is di-vided by thin partitions.—87. *Cork-like* (suberosus), where the outer rind is soft and spongy; as in the Ulmis subero-rosa.—88. *Rifted* (rimosus), where there are in the rind thin clefts or chinks.—89. *Scarred* (cicatrizatus), having scars formed by the falling off of the leaves.

The STRAW (culmus), is proper only to the grasses. The kinds of it are nearly the same with those of the stem. The following, however, may be distinguished in addition:—

1. *Knotted* (nodosus), furnished with enlarged joints, as most of the grasses.—2. *Knotless* (enodis), without any such enlarged joints. Juncus, Carex, Scirpus.—3. *Simple* (simplex), having no branches.—4. *Branched* (ramosus), furnished with branches.—5. *Leafy* (frondosus), furnished with irregular branches, and particularly with small leaves, as Restio.—6. *Sheathed* (vaginatus), that is covered with foliaceous vagina.—7. *Naked* (nudus), having neither foliaceous vagina nor any leaves.—8. *Erect* (erectus), standing quite upright.—9. *Geniculated* (geniculatus or in-fractus), when the first and undermost joint lies prostrate, and the rest stand upright, so that by this flexure nearly a right angle is formed; as in Alopecurus geniculatus.—10. *Oblique* (obliquus), having such a direction as to be intermediate between perpendicular and horizontal; as Poa annua.

The SCAPE (scapus,) is an herbaceous stem that bears flowers but not leaves, and proceeds from the descend-ing or intermediate, but never from the ascending stem.

It is proper to the lilies, and is sometimes found in other plants; but in this last case it ought to bear more than one flower, for had it but one flower it would be called pedunculus radicalis. It is only when this single flower sits on a flower-stalk proceeding immediately from the ground that it is called scape.

The STIPE (stipes). This term is applied only to Filices, Fungi, and Palms. The following are the kinds of it:—

In Filices.

1. *Chaffy* (paleaceus), when it is covered with dry membranaceous scales.—2. *Scaly* (squamosus), when it is covered with foliaceous scales.—3. *Naked* (nudus), without any covering.—4. *Prickly* (aculeatus), having prickles.—5. *Smooth* (inermis), without prickles.

In Fungi.

6. *Fleshy* (carnosus), of a fleshy substance.—7. *Leathery* (coriaceus), consisting of a tough leather-like substance, as Boletus perennis.—8. *Firm* (solidus), consisting within of a solid mass.—9. *Hollow* (fistulosus), forming throughout a hollow cylinder.—10. *Pitted* (lacunosus), having depressions on the outside; as Helvella sulcata.—11. *Scaly* (squamosus), covered with firmly attached scales.—12. *Squarrose* (squarrosus), covered with scales which are turned back at the points.—13. *Raised* (peronatus), that from the bottom to the middle is laid thick over with a woolly substance ending in a sort of meal.—14. *Bellying* (ventricosus), thicker in the middle than at either end.—15. *Bulb-like* (bulbosus), that is thick immediately above the root.

The SHOOT (surculus), is a term applied to the stem which bears the leaves of the mosses. Of this there are the following varieties:—

1. *Simple* (simplex), having no branches; as in the Polytrichum commune.—2. *Branched* (ramosus), dividing into branches; as in Mnium androgynum.—3. *With hanging branches* (ramis deflexis), when the stem is branched, but all the branches hang down; as in Sphagnum palustre.—4. *Irregular* (vagus), branched, but the branches set

on without order.--5. *Intricate* (intricatus), branched, and the numerous protuberant branches running into one another.—6. *Tree-like* (dendroides), standing erect, and at the point a crowd of thick branches like the top of a tree.—7. *Pinnated* (pinnatus), having at two opposite sides simple branches, of nearly the same length, at equal angles with the stalk.—8. *Doubly pinnated* (bipinnatus), having the habit of the last, only that its branches are again divided like those of the principal stem; as Hypnum parietinum.—9. *Trebly pinnated* (triplicatio pinnatus), like the last, but the secondary branches are also pinnated; as Hypnum recognitum.—10. *Proliferous* (prolifer), when, in either of the two last kinds, there shoots forth a new stem out of the old; as in Hypnum proliferum.—11. *Erect* (eructum), which rises perpendicularly; as in Polytrichum commune.—12. *Prostrate* (procumbens), lying along.—13. *Creeping* (repens), the same with the last, but the branches constantly lengthening and putting forth small roots.—14. *Floating* (fluctuans), swimming under water in a perpendicular direction, and attached to some fixed body; as Fontinalis antipyretica.

The Sarment or Runner (sarmentum), is a filiform stem, springing from the root and shooting from the point, so sending forth roots, and producing a new plant of the same kind; as Saxifraga sarmentosa, Fragaria.

The Sucker (stolo), is a foliaceous creeping stem springing from the root, covered on its under surface with small roots, but at the point bearing a number of leaves from which comes a new plant; as Ajuga reptans, Hieracium pilosella.

The Foliage consists of the leaves, and their several parts, with the tendrils or other appendages connected therewith. The leaves are the organs in which the juices of the plant are elaborated, and rendered fit for being ap-

turned into the system, through the descending vessels of the bark and the radiating vessels of the wood. They begin where the primordial scales at the base of the plant, if any, terminate; and they cease to be considered leaves as soon as the inflorescence (inflorescentia, commences; if situated among the inflorescence they are denominated bracteæ.

The leaf is divided into three distinct parts: the *stipulæ*, the *petiole*, the *laminæ*.

The *stipulæ* are minute scale-like appendages, seated at the base of the common or partial petiole: occasionally they are foliaceous; their position is liable to slight variation, being sometimes at the base of the petiole, sometimes adnate with its margin, and occasionally placed on the side of the stem opposite to the petiole. The stipulæ are to the leaf what the bracteæ are to the flowers.

The *petiole* is the footstalk of the leaf, and is subject to nearly the same variations in form as the stem; the terms applied to which are equally applicable to the petiole.

The *lamina* is a term used to express the leaf itself, considered without reference to the petiole or stipulæ.

Leaves are said to be simple when they consist of one lamina only; and to be compound, when they are formed by the union of more laminæ than one. The following are the terms employed in speaking of leaves:---

A. Simple Leaves.

In respect of the apex.

A leaf is said to be:—

1. *Acute* (acutum), when the leaf ends in a point.—2. *Acuminated* (acuminatum), when the point is lengthened out.—3. *Pointed* (cuspidatum), when the lengthened-out point ends in a small bristle.—4. *Obtuse* (obtusum), when the end of the leaf is blunt or round.—5. *Mucronate* (mucro-

natum), when there is a bristle-shaped aculeus situated on the round end of a leaf; as in the Amaranthus blitum. —6. *Bitten* (præmorsum), when the leaf is as it were bitten off at the point, forming a curved line; as in the Pavonia præmorsa.—7. *Truncated* (truncatum), when the point of the leaf is cut across by a straight line; as in the Liriodendron tulipifera.—8. *Wedge-shaped* (cunieforme), when a truncated leaf is pointed on both sides at the base.—9. *Dædaleous* (dædaleum), when the point has a large circuit, but is truncated and ragged.—10. *Emarginated* (emarginatum), when an obtuse pointed leaf has a part as it were taken out of the apex.—11. *Retuse* (retusum), when an obtuse leaf is somewhat emarginated, but in a small degree.—12. *Cleft* (fissum), when there is a cleft at the point extending half way down the leaf. When there is but one cleft at the point, the leaf is called bifid (folium bifidum); if there are two clefts, it is called trifid (trifidum); if there are more clefts, the leaf is called quadrifidum, quinquefidum, &c.; multifidum, with many clefts.—13. *Fan-shaped* (flabelliforme), when a truncated cuneiform leaf is at the point once or oftener cleft.—14. *Tridentated* (tridentatum), when the point is truncated, and has three indentations.

In respect of the base.

15. *Heart-shaped* (cordatum), when the base is divided into two round lobes, the anterior part of the leaf being ovate.--16. *Kidney-shaped* (reniforme), when the base is divided into two round separate lobes, and the anterior part of the leaf is round.—17. *Moon-shaped* (lunatum), when both lobes at the base have either a straight or somewhat arched line, and the anterior part of the leaf is round. ---18. *Unequal* (inæquale), when one side of the leaf is more produced than the other.—19. *Arrow-shaped* (sagittatum), when the base is divided into two projected points

ed lobes, and the anterior part of the leaf is likewise pointed.---20. *Spear-shaped* (hastatum), when the two pointed lobes of the base are bent outwards.---21. *Ear-shaped* (auriculatum), when there are at the base two small round lobes bent outwards. It is nearly the hastate leaf, only the lobes are smaller and round.

In respect of circumference.

22. *Orbicular* (orbiculatum), when the diameter of the leaf on all sides is equal.---23. *Roundish* (subrotundum), differs little from the foregoing, only that the diameter is longer, either from the base to the apex or from side to side.---24. *Ovate* (ovatum), a leaf which is longer than it is broad; the base is round and broadest, the apex narrowest.---25. *Oval or elliptical* (ovale or ellipticum), a leaf whose length is greater than its breadth, but round both at base and apex.---26. *Oblong* (oblongum), when the breadth to the length is as one to three, or the breadth always least; but the apex and base vary, that is, they are sometimes obtuse, sometimes pointed.---27. *Parabolic* (parabolicum), a leaf is so called which is round at the base, then forms a small bend, and grows less towards the point.---28. *Spatulate* (spatulatum), when the fore part of a leaf is circular, growing smaller towards the base; as in the Cucubalus otites.---29. *Rhombic* (rhombeum), when the sides of the leaf run out into an angle, so that the leaf represents a square.---30. *Oblique* (subdimidiatum), is that leaf which has one side broader than the other.

Of this leaf there are several varieties: as *a. Heart-shaped oblique* (sub-dimidiatio-cordatum), a heart-shaped leaf, which is at the same time oblique; as in the Begonia nitida. *b. Trapeziform* (trapeziforme), a rhombic leaf, with one side smaller than the other, &c.—31. *Panduræform* (panduræforme), when an oblong leaf has a deep curve on

both sides.—32. *Sword-shaped* (ensiforme), an oblong leaf, growing gradually narrower towards the apex, which is pointed, the sides are flat, and have more or less of an arch-like form; as in the sword-flag, Iris.—33. *Lanceolate* (lanceolatum), an oblong leaf which grows gradually narrower from the base to the point.—34. *Linear* (lineare), when both sides of a leaf run parallel to each other, so that it is equally broad at the base and the apex.—35. *Capillary* (capillare), when a leaf has scarcely any breadth, and is as fine as a thread or hair.—36. *Awl-shaped* (subulatum), a linear leaf, which is sharply pointed.—37. *Needle-shaped* (acerosum), a linear leaf that is rigid, and generally endures through the winter; as in the pine tribe, Pinus.—38. *Triangular* (triangulare), when the circumference represents a triangle, the apex of which makes the point of the leaf; as in the birch, Betula alba.—39. *Quadrangular, quinquangular* (quadrangulare, quinquangulare), when the circumference of the leaf has four or five angles; as in the Menispermum Canadense.—40. *Entire* (integrum, indivisum), which is not at all cleft or divided.—41. *Lobed* (lobatum), when a leaf is deeply divided, nearly half its length, into lobes. According to the number of lobes it is denominated bi-lobed (bi-lobum), as in Bauhinia; tri-lobed (tri-lobum), quinquelobed (quinquelobum), as in the hop, Humulus lupulus, &c.—42. *Palmated* (palmatum), when there are five or seven very long lobes, that is, when the segments are more than half way divided.—43. *Divided* (partitum), when in a roundish leaf the division extends to the base; Ranunculus aquatilis.—44. *Two-ranked* (dichotomum), the last leaf, whose linear sections are divided or subdivided into twos.—45. *Torn* (laciniatum), when an oblong leaf has several irregular clefts.—46. *Sinuated* (sinuatum), when on the sides of an oblong leaf there are round incisures, as in the oak, Quercus robur.—47. *Pinnatifid*

(pinnatifidum), when there are regular incisures, to go almost to the middle rib.—48. *Lyre-shaped* (lyratum), nearly the foregoing leaf, whose outer segment is very large and round.—49. *Runcinate* (runcinatum), when the incisures of a pinnatifid leaf are pointed, and form a curve behind, as in the dandelion, Leontodon taraxacum.—50. *Squarroso-laciniate* (squarroso-laciniatum), when the leaf is cut almost into the middle rib, and the incisures run in every direction; as in the thistle, Carduus lanceolatus. N. B. The contour of the leaves from No. 41 to 43 is round; from 44 to 49 it is oblong.

In respect of the margin.

51. *Quite entire* (integerrimum), when the margin is without either notch or indentation. N. B. This No. 50 and No. 40 are often confounded. An entire leaf is merely the opposite of the numbers from 40 and 41 to 49. It may often be either dentated or serrated. A quite entire leaf may, indeed, be formed like numbers from 41 to 47, but it can have no indentations or serratures, as in the following leaves:—

52. *Cartilagineous* (cartilagineum), when the margin consists of a border of a harder substance than the disk.—53. *Undulated* (undulatum), when the margin is alternately bent in and out.—54. *Crenated* (crenatum), when the margin is set with small and round notches, having at the same time a perpendicular position.—55. *Repand* (repandum), when there are on the margin small sinuses, and between them segments of a small circle.—56. *Toothed* (dentatum), when the margin is set round with small pointed and distinctly separated teeth.—57. *Duplicato-dentate* (duplicato-dentatum), when each small tooth of the margin is again dentated; as in the elm, Ulmus campestris.—58. *Dentato-crenate* (dentato-crenatum), when each tooth is set

with small and round denticuli.—59. *Serrated* (serratum), when the teeth on the margin are very sharp-pointed, and stand so close that one seems to lie on the back of another. —60. *Gnawed* (erosum), when the margin is unequally sinuated, as if it had been gnawed; as in some species of sage, Salvia.—61. *Spiny* (spinosum), when the margin is set with spines; as in the thistle, Carduus.—62. *Fringed* (ciliatum), when the margin is set round with strong hairs, of equal length, and at a considerable distance from one another.

In respect of the surface.

63. *Aculeated* (aculeatum), when the surface is covered with spines.—64. *Hollow* (concavum), when there is a hollow in the middle of the leaf.—65. *Channelled* (canaliculatum), when the middle rib of a long and narrow leaf is furrowed.—66. *Wrinkled* (rugosum), when the surface is raised between the veins of the leaf, and thus forms wrinkles; as in sage, Salvia.—67. *Bullate* (bullatum), when the parts raised between the veins on the surface appear like blisters.—68. *Pitted* (lacunosum), when the raised places between the veins are on the under surface, so that the upper surface appears pitted.—69. *Curled* (crispum), when the leaf is fuller on the margin than in the middle, so that it must lie in regular folds.—70. *Folded* (plicatum), when the leaf lies in regular straight folds from the base.—71. *Veined* (venosum), when the vessels of a leaf rise out of the middle rib. This is the case in most plants.—72. *Net-wise-veined* (reticulato-venosum), when the veins which rise from the middle rib again subdivide into branches, that form a sort of network.—73. *Ribbed* (costatum), when the veins arise out of the middle, and proceed in a straight line towards the margin in considerable numbers, and close together; as in the Calophyllum inophyllum, Canna, Musa,

&c.—74. *Nerved* (uervosum), when the vessels rising out of the petiolus rūn from the base to the apex.—75. *Three-nerved* (trinervium), when three nerves take their origin from the base. Thus we likewise say, quinquenervium, septemnervium, &c.—76. *Triple-nerved* (triplinervium), when out of the side of the middle rib, above the base, there arises a nerve running towards the point; as in Laurus Cinnamomum, and Camphora.—77. *Quintuple-nerved* (quintuplinervium), when out of the middle rib, above the base, there arise on each side two nerves running towards the point.—78. *Septuple-nerved* (septuplinervium), when on each side of the middle rib, above the base, three nerves arise, and proceed to the apex.—79. *Venose-nerved* (venoso-nervosum), when, in a leaf having nerves, the vessels run into branches, or in a veined leaf; as in the Indian cress, Tropæolum majus.—80. *Streaked* (lineatum), when the whole leaf is full of smooth parallel vessels, that run from the base to the apex.—81. *Nerveless* (enervium), when no nerves rise from the base.—82. *Veinless* (avenium), where there are no veins.—83. *Dotted* (punctatum), when instead of ribs and veins there are dots or points; as in the Vaccinium vitis idæa.—84. *Coloured* (coloratum), a leaf of some other colour than green.—85. *Cowled* (cucullatum), when in a heart-shaped leaf the lobes are bent towards each other so as to have the appearance of a cowl.—86. *Convex* (convexum), when the middle of the leaf is thicker than the rim, raised on the upper surface and hollowed on the under.—87. *Keel-shaped* (carinatum), when on the under surface of a linear-lanceolate, or oblong leaf, the place of the middle rib is formed like the keel of a ship.—88. *Quadruply-keeled* (quadricarinatum), when the middle rib, by means of a thin leaf above and below, projects, and the margin is incrassated, so that a horizontal section has the appearance of a cross; as Ixia cruciata.

B. Compound Leaves.

89. *Compound* (compositum), when several leaves are supported by one footstalk. To this term belong Nos. 89, 92, 95, 96, 97. But when the leaf agrees with the above definition, although it should not come under any of the following kinds, it is still to be considered a compound leaf.---90. *Fingered* (digitatum), when the base of several leaves rests on the point of one footstalk; as in the horse-chestnut, Æsculus Hippocastanum.—91. *Binate* (binatum), when two leaves stand by their base on the top of one footstalk; but if the two foliola of a binate leaf bend back in a horizontal direction, it is called a conjugate leaf, folium conjugatum.—92. *Bigeminate* (bigeminatum, bigeminum), when a divided leaf-stalk at each point bears two leaves; as in some species of Mimosa.—93. *Trigeminate* (trigeminatum or tergeminum), when a divided leaf-stalk on each point bears two leaves, and on the principal stalk, where it divides, there is a leaf at each side; as in the Mimosa tergemina.---94. *Ternate* (ternatum), when three leaves are supported by one footstalk; as in the clover, Trifolium pratense. Strawberry, fragaria vesca.—95. *Biternate* (biternatum or duplicato-ternatum), when a foot-stalk, which separates into three, at each point bears three leaves.---96. *Triternate* (triternatum or triplicato-ternatum), when a footstalk, which separates into three, is again divided at each point into three, and on each of these nine points bears three leaves.---97. *Quadrinate* (quadrinatum), when four leaves stand on the point of a leaf-stalk; as Hedysarum tetraphyllum.—98. *Quinate* (quinatum), when five leaves are supported by one footstalk: this, it is true, has some affinity with No. 89, but varies on account of the number five, as in the other there are generally more leaves.---99. *Umbellate* (umbellatum), when at the point of

a leaf-stalk there stand a number of leaves, closely set, and forming the figure of a parasol; as Aralia sciodaphyllum, Panax chrysophyllum.---100. *Pedate* (pedatum, ramosum), when a leaf-stalk is divided, and in the middle, where it divides, there is a leafet; at both ends there is likewise a leafet, and on each side, between the one in the middle and that at the end, another or two, or even three leaves. Such a leaf therefore consists of five, seven, or nine leafets, that are all inserted on one side; as in the Helleborus viridis, fœtidus, and niger.—101. *Pinnated* (pinnatum), when on an undivided leaf-stalk there is a series of leafets on each side, and on the same plane; of this there are the following kinds: *a. Abruptly pinnated* (pari pinnatum, or abrupte pinnatum) when at the apex of a pinnated leaf there is no leafet.—*β. Pinnate with an odd one* (impari-pinnatum, or pinnatum cum impari), when at the apex of a pinnated leaf there is a leafet.---*γ. Oppositely pinnate* (opposité pinnatum), when the leafets on a pinnated leaf stand opposite to one another. ---*δ. Alternately pinnate* (alternatim pinnatum), when the leafets on a pinnated leaf stand alternately.---*ι. Interruptedly pinnate* (interruptè pinnatum), when in a pinnated leaf each pair of alternate leafets is smaller.—*ζ. Jointedly pinnate* (articulatè pinnatum), when between each pair of opposite pinnæ, or leafets, the stem is furnished with a jointed edge.---*η. Decursively pinnate* (decursivè pinnatum), when from each particular pinnula a foliaceous appendage runs down to the following one.—*ϑ. Decreasingly pinnate* (pinnatum foliolis decrescentibus), when the successive foliola on a pinnated leaf grow gradually smaller to the point; as in the Vicia sepium.---102. *Conjugately pinnated* (conjugato-pinnatum,) when a leaf-stalk divides, and each part makes a pinnated leaf.---103. *Ternato-pinnate* (ternato-pinnatum), when at the point of a principal leaf-stalk

there stand three pinnated leaves; as Hoffmanseggia.—104. *Digitato-pinnate* (digitato-pinnatum), when several simply pinnated leaves, from four to five, stand on the point of one stalk; as in Mimosa pudica.—105. *Doubly pinnate* (bipinnatum, duplicato-pinnatum), when a leaf-stalk bears, on one plane on both sides, a number of leaf-stalks, of which each is a pinnated leaf.—106. *Trebly pinnate* (triplicato-pinnatum, or tripinnatum), when several doubly pinnated leaves are attached to the sides of a foot-stalk on one plane.—107. *Doubly compound* (decompositum), when a divided leaf-stalk connects several leaves; of this kind are Nos. 90, 91, 93, 98, 99, 100. But the term decompositum is only used when the division of the leaf-stalk of the pinnulæ is irregular.—108. *Suver-decompound* (supra-decompositum), when a leaf-stalk, which is often divided, sustains several leaves; to this belong Nos. 94, 101. But then the term is used only when the divisions of the leafets are either more numerous or not so regular.

In respect of the place.

109. *Radical* (radicale), when a leaf springs from the root, as in the violet, Viola odorata. Sagittaria sagittifolia.—110. *Seminal* (seminale), when a leaf grows out of the parts of the seed, as in the hemp; where, as soon as it springs, there appear two white bodies, which are the two halves of the seed that change into leaves.—111. *Cauline* (caúlinum), which is attached to the principal stem. The root leaves and stem leaves of a plant are often very different.—112. *Rameous* (rameum), when a leaf rises from the branches.—113. *Axillary* (axillare or subalare), which stands at the origin of the branch.—114. *Floral* (florale), which stands close by the flower.

In respect of substance.

115. *Membranaceous* (membranaceum), when both membranes of a leaf lie close upon one another, without any pulpy substance between them; as in the leaves of most trees and plants.—116. *Fleshy* (carnosum), when between the membranes there is much soft and pulpy substance; as in houseleek, Sempervivum tectorum.—117. *Hollow* (tubulosum), when a somewhat fleshy and long leaf, as in the onion, Allium Cepa.—118. *Bilocular* (biloculare), when in a linear leaf, internally hollow, the cavity is divided by a longitudinal partition into two. Lobelia dortmanna.—119. *Articulate* (articulatum, or loculosum), when a cylindrical hollow leaf has its cavities divided by horizontal partitions; as Juncus articulatus.—120. *Cylindrical* (teres), when it is formed like a cylinder.—121. *Compressed* (compressum), when a thick leaf is flat on both sides.—122. *Two-edged* (anceps), when a compressed leaf is sharp on both edges.—123. *Depressed* (depressum), when the upper surface of a fleshy leaf is pressed down, or, as it were, hollowed out.—124. *Flat* (planum), when the upper surface of a thick leaf forms an even plane.—125. *Gibbous* (gibbosum, or gibbum), when both surfaces are convex.—126. *Scimitar-shaped* (acinaciforme); a two-edged thick leaf, on one side sharp and arched, on the other straight and broad. —127. *Axe-shaped* (dolabriforme), when a fleshy leaf is compressed, circular on the upper part, convex on the one side, sharp edged on the other, and cylindrical at the base. —128. *Tongue-shaped* (linguiforme), when a long compressed leaf ends in a round point.—129. *Three-sided* (triquetrum), when the leaf is bounded by three narrow sides, and is at the same time long.—130. *Deltoid* (deltoideum), when a thick leaf is bounded by three broad surfaces, and is at the same time short.—131. *Four-cornered* (tetrago-

num), when a leaf, long in proportion, is bounded by four narrow surfaces; as in the Pinus nigra.—132. *Warty* (verrucosum), when short fleshy leaves are truncated, and stand in thick heaps; as in some Euphorbiæ.—133. *Hooked-shaped* (uncinatum), when a fleshy leaf is flat above, compressed at the sides, and bent back at the point.

In respect of situation and position.

134. *Opposite* (folia opposita), when the bases of the leaves are next each other, on opposite sides of a stem. —135. *Dissimilar* (disparia), when of two leaves, placed opposite, the one is quite differently formed from the other; as some species of Melastoma.—136. *Alternate* (alterna), see No. 11.—137. *Scattered* (sparsa), when the leaves stand thick on the stem, without any order.—138. *Crowded* (conferta, or approximata), when the leaves stand so close together that the stem cannot be seen.—139. *Remote* (remota), when the leaves are separated on the stem by certain interstices.—140. *Three-together* (terna), when three leaves stand round the stem: there are sometimes four, five, six, seven, eight, &c., quaterna, quina, sena, septena, octona, &c.—141. *Starlike* (stellata, or verticillata), when several leaves stand round the stem at certain distances; as in ladies-bed straw, Galium, &c.—142. *Tufted* (fasciculata), when a number of leaves stand on one point; as in the larch, Pinus larix, Celastrus buxifolius.—143. *Two-rowed* (disticha), when leaves are so placed on the stem that they stand on one plane; as in the pitch fir, Pinus picea, Lonicera symphoricarpus.—144. *Decussated* (decussata), when the stem, in its whole length, is set round with four rows of leaves at each branch, and when one looks perpendicularly down upon it, the leaves seem to form a cross; as in Veronica decussata.—145. *Imbricated* (imbricata), when one leaf lies over another, as the tiles upon a roof. Of

this there are the following kinds:—*a. Bifariously imbricated* (bifariam imbricata), when the leaves are so laid upon one another that they form but two rows longitudinally on the stem.—*β. Trifariam imbricata,* three rows.—*γ. Quadrifariam imbricata,* &c. four rows, &c.

F. In respect of insertion.

146. *Petiolated* (petiolatum), when a leaf is furnished with a foot-stalk.—147. *Palaceous* (palaceum), when the foot-stalk is attached to the margin.—148. *Peltated* (peltatum), when the foot-stalk is inserted into the middle of the leaf.—149. *Sessile* (sessile), when the leaf is attached to the stem without any foot-stalk.—150. *Loose* (solutum, or basi solutum), a succulent cylindrical or subulate leaf, which seems to have no connexion with the stalk on which it rests, but seems to hang the more loosely; as Sedum album.—151. *Riding* (equitans), a sword-shaped or linear leaf, that forms at its base a sharp and deep furrow, whose surfaces lie on one another, and embrace the stalk; Dracæna ensifolia, Sisyrinchium striatum, &c.—152. *Decurrent* (decurrens), when the foliaceous substance of a sessile leaf runs down along the stem.—153. *Embracing* (amplexicaule), when a sessile leaf is heart-shaped at the base, and with both lobes embraces the stem.—154. *Connate* (connatum , when opposite and sessile leaves are joined at their base.—N. B. A *perfoliated leaf* (folium perfoliatum), is already described in No. 59.

F. In respect of direction.

155. *Appressed* (appressum), when the leaf turns up, and lays its upper surface to the stem.—156. *Erect* (erectum, or semiverticale), when the leaf is directed upwards, and makes with the stem a very acute angle.—157. *Vertical* (verticale), which stands quite upright, and thus makes

with the horizon a right angle.—158. *Bent sideways* (adversum), when the margin of a vertical leaf is turned towards the stem.—159. *Spreading* (patens), which goes off from the stem in an acute angle.—160. *Bent in* (inflexum, or incurvum), when an upright leaf is bent in at its point towards the stem.—161. *Oblique* (obliquum), when the base of the leaf stands upwards, and the point is turned towards the ground.—162. *Horizontal* (horizontale), when the upper surface of the leaf makes with the stem a right angle.—163. *Bent down* (reclinatum, or reflexum), when the leaf stands with its point bent towards the earth.—164. *Bent back* (revolutum), when the leaf is bent outwards, and its point from the stem.—165. *Hanging down* (dependens), when the base is turned to the zenith, and the point towards the ground.—166. *Rooting* (radicans), when the leaf strikes root.—167. *Swimming* (natans), when the leaf swims on the surface of water; as in Nymphæa alba.—168. *Immersed* (demersum), when the leaves are found under water.—169. *Emerging* (emersum), when the leaf of an aquatic plant raises itself out of the water.

Besides the petiole, the stipulæ, and the lamina, which have now been described, there are two appendages which properly belong to the foliage, and still remain to be noticed; these are the ramentum, and the cirrhus, or tendril.

The Rament (ramentum), is a small, often bristle-shaped, leafet, that is oblong, thin, and more or less of a brown color; sometimes placed, like the stipulæ, in the angles of the petiole; but sometimes, likewise, without any order on the stem. It appears on all trees when their buds open, and falls soon after. On the oak it stands like the stipulæ, on the Scotch fir, Pinus sylvestris, it is soon dispersed.

When the stem of a plant is covered with fine dry scales, that have the appearance of the Ramentum, it is properly called a ramentaceous stem, caulis ramentaceus.

The TENDRIL (cirrhus), is a filiform body, which serves for attaching plants to some support. It is always an alteration of some other part of the plant; for instance, in the vine, of a leaf, and in the Artobotrys, of a part of the inflorescence. Climbing plants are furnished with tendrils. They are in general spiral. The species are as follows:—

1. *Axillary* (axillaris), when rising from the axillæ of the leaves.—2. *Foliar* (foliaris), when springing from the points of the leaves.—3. *Petiolar* (petiolaris), when standing on the point of the common foot-stalk of a compound leaf.—4. *Peduncular* (peduncularis), when rising from the foot-stalk of a flower.—5. *Simple* (simplex), when not divided. —6. *Convolute* (convolutus), when winding regularly round a prop.—7. *Revolute* (revolutus), when winding irregularly, sometimes to this side, sometimes to that.

To the inflorescence are to be referred all those parts which are placed above the articulation, which unites the flower with the plant: strictly speaking, the term denotes the mode in which the flowers are arranged upon their stalk or rachis. We will first describe the different manners in which this is effected, and then explain the nature and modifications of the accessory leaves.

The inflorescence in many plants is an important character, and the following kinds have been described, viz.: The whirl (verticillus), the head (capitulum), the ear (spicula), the spike (spica), the raceme (racemus), the fascicle (fasciculus), the umbel (umbella), the cyme (cyma), the corymb (corymbus), the panicle (panicula), the thyrse (thyrsus), the spadix (spadix), and finally, the catkin (amentum).

A WHIRL (verticillus), consists of several flowers that encircle the stem, and stand uncovered at intervals upon it. Of this there are the following kinds:—

1. *Sitting* (sessilis), when all the flowers sit close to the stem, without foot-stalk, as in the field mint. Mentha arvensis.—2. *With a foot-stalk* (pedunculatus), when the flowers are furnished with short foot-stalks.—3. *Headed* (capitatus), when the flowers stand so thick that they take the figure of a half sphere; as Phlomis tuberosa.—4. *Half* (dimidiatus), when the flowers surround only the half of the stalk; as in balm, Melissa officinalis.—5. *Close* (confertus), when one whirl stands close above another.—6. *Distant* (distans), when the whirls stand at a distance one from another.—7. *Leafy* (foliosus), when there are leaves at the base of the whirl.—8. *Leafless* (aphyllus), when there are no leaves above the whirl.—9. *Bracteate* (bracteatus), when there are floral leaves, or bracteæ at the whirl.—10. *Ebracteate* (ebracteatus), when there are no bracteæ at the whirl.—11. *Naked* (nudus), when no leaves or bracteæ stand near the whirl.—12. *Six, eight, ten, or many flowered* (sex, octo, decem, or multiflorus), when the whirl consists of many flowers.

The Head (capitulum), is a number of flowers standing thick upon one stalk, so as to form a round head. The flowers have either foot-stalks, or sit close. The following are varieties of this:—

1. *Spherical* (globosum, or sphæricum), when the flowers have a perfectly round form; as in the Gomphrena globosa. —2. *Roundish* (subglobosum), when the head of flowers is nearly round, but where the length exceeds the breadth; as in clover; Gomphrena globosa.—3. *Conical* (conicum), when the head is long, drawing towards a point; as in Trifolium montanum.—4. *Hemispherical* (dimidiatum, or hemisphericum), when the head is round on one side and flat on the other.—5. *Leafy* (foliosum), when the head is surrounded with leaves.—6. *Tufted* (comosum), having leaves at the point; as Bromelia ananas.—7. *Naked* (nudum),

when it is devoid of leaves.—8. *Standing on the point* (terminale), when it stands on the top of the stem.—9. *Axillary* (axillare), standing on the angles of the leaves, that is, where the base of the leaf, or of the leaf-stalk, is placed.—10. *Alar* (alaris), sitting on the axillæ of the branches.

The EAR (spicula or locusta), is either named from the flowers of the grasses enclosed in the glume; or we understand by it also, the flowers of the gramineous plants, such as cyperus, scirpus sylvaticus, &c., which stand closely pressed together on a filiform flower-stalk. It is denominated according to the number of the flowers and their figures.—The following are the kinds of it:—

1. *One-flowered* (uniflora), that contains but one flower; as Agrostis.—2. *Two-flowered* (biflora), having two flowers; as in Aria.—3. *Three-flowered* (triflora), &c.—4. *Many-flowered* (multiflora), that contains many flowers.—5. *Round* (teres), when the flowers in the spicula are so placed that their horizontal section is round; as Glyceria fluitans, &c.—6. *Two-ranked* (disticha), when the flowers in the spicula are placed in two opposite rows on the same level; as in Cyperus.—7. *Ovate* (ovata), when the outline of the spicula resembles the figure of an egg; as Bromus secalinus.—8. *Oblong* (oblonga), when the outline of the spicula exhibits an ellipsis more or less perfect.—9. *Linear* (linearis), when the spicula is long and small, but of equal breadth throughout.

The SPIKE (spica) is that sort of inflorescence when many flowers, without any foot-stalk, sit on a simple filiform principal flower-stalk. If there be a foot-stalk, it must be much shorter than the flower. The kinds are,

1. *Glomerate* (glomerata), when the spike consists of a spherical selection of flowers.—2. *Interrupted* (interrupta), when the flowers upon the spike are interrupted by naked interstices.—3. *Verticillated* (verticillata), when the flowers,

leaving naked interstices on the spike, appear on that account to be placed in whirls.—4. *Imbricated* (imbricata), when the flowers stand so thick together that one lies upon another.—5. *Distichous* (disticha), when the flowers are arranged on the spike in two rows.—6. *One-rowed* (secunda), when the flowers are all arranged on one side of the spike, so that the other side is naked.—7. *Cylindrical* cylindrica), when the spike is equally covered with flowers both above and below.—8. *Linear* (linearis), that is very slender, and of equal thickness.—9. *Ovate* (ovata), that is thick above, more slender below, appears of an oval form. —10. *Ventricose* (ventricosa), thick in the middle, and slender at both extremities.—11. *Leafy* (foliosa), having leaves between the flowers.—12. *Comose* (comosa), having leaves at the apex.—13. *Fringed* (ciliata), having hairs between the flowers.—14. *Simple* (simplex), without branches.—15. *Branched or compound* (ramosa, or composita), when several spikes stand on one branched or divided stalk.—16. *Conjugate* (conjugata), when two spikes standing on one stalk unite at the base.—17. *Bundled* (fasciculata), when several spikes standing on one foot-stalk unite at the base.—18. *Terminal* (terminalis), standing on the apex of the stalk or branch.—19. *Axillary* (axillaris), standing in the angles at the origin of the leaves.—20. *Lateral* (lateralis), standing on the wood of the former year, that is, on the place now destitute of leaves.

The Raceme (racemus) is that sort of infloresence to which several pedunculated flowers are longitudinally attached, nearly of equal length, or at least where the lowest flower-stalks are little longer than the upper. Here follow the different kinds of Raceme:—

1. *One-sided* (unilateralis), when only one side of the stem is set with flowers.—2. *One-rowed* (secundus), when the flower-stalks are situated round the principal stem, but

the flowers themselves are directed only to one side.—3. *Limber* (laxus), when the raceme is very pliant and flexible. —4. *Stiff* (strictus), when the raceme does not bend.—5. *Simple* (simplex), when it is unbranched.—6. *Compound* (compositus), when several single racemes unite on one stem.—7. *Conjugate* (conjugatus), when two racemes, standing on one stem, unite at the base.—8. *Naked* (nudus), without leaves or bracteæ.—9. *Foliate* (foliatus), set with leaves or bracteæ.—10. *Bracteate* (bracteatus), when there are bracteæ at the flowers.—11. *Ebracteate* (ebracteatus), having no bracteæ.—12. *Erect* (erectus), standing upright.—13. *Straight* (rectus), straight without bending.—14. *Cernuous* (cernuus), when the apex of the raceme is bent downwards. —15. *Nodding* (nutans), when the half of the raceme is bent downwards.—16. *Hanging* (pendulus), when the raceme hangs down perpendicularly.

The Fascicle or bundle (fasciculus) is a number of simple foot-stalks, of equal height, which arise at the point of the stem, not from one point, but from several. As an example of the fasciculus may be quoted Dianthus carthusianorum.

The Umbel (umbella) consists of a number of flower-stalks, of equal length, that rise from the point. In an umbel the flower-stalks are called rays (radii). There are the following varieties of the umbel :—

1. *Simple* (simplex), when the rays bear but one flower.—2. *Compound* (composita), when each ray of the umbel supports a simple umbel. The rays which support the simple umbels are called the universal or general umbel, umbella universalis. The simple umbels are called the particular or partial umbels, umbella partialis or umbellula.—3. *Sitting* (sessilis), when the umbel has no stalk.—4. *Pedunculated* (pedunculata), when it is furnished with a stalk.—5. *Close* (conferta), when the rays of the umbel stand so near

one to another that the whole umbel becomes very thic and close.—6. *Distant* (rara), when the rays stand wide.— *Poor* (depauperata), when the umbel has but few flowe —8. *Convex* (convexa), when the middle rays are high b stand thick, so that the whole form a globular figure.— *Flat* (plana), when the rays being of equal length, t flowers form a flat surface.

The CYME (cyma) is that species of inflorescence whe the whole at first view has the appearance of a compou umbel, only the principal flower-stalk and those which su port the particular florets do not rise from the same poi The flower-stalks rise close above one another, and a divided into irregular branches. Examples of the cy are found in Sambucus nigra, and Viburnum opulus.

The CORYMB (corymbus) is, properly speaking, an ere racemus, the lower flower-stalks of which are either branc ed or simple, but always so much produced as to be equal height with the uppermost.

The PANICLE (panicula) consists of a number of sim flowers that stand on unequally divided branches, and o long peduncle. The kinds are,

1. *Simple* (simplex), that has only undivided side branch —2. *Branched* (ramosa), when the branches are ag branched.—3. *Much branched* (ramosissima), when the s branches are much divided.—4. *Disappearing* (deliquesce when the foot-stalk so loses in branching that it cannot traced to the end.—5. *Spreading* (patentissima), when branches stand wide from one another, and spread out all sides.—6. *Crowded* (coarctata), when the branches st very close together.—7. *One-rowed* (secunda), when branches incline all to one side.

The THYRSE (thyrsus) is a condensed panicle, wh branches are so thick that the whole has an oval form;- in the flower of the privet, Ligustrum vulgare, Tussil petasites.

The SPADIX is peculiar to the palms, and some plants allied to the genus Arum. All flower-stalks that are contained in a vagina, are called Spadix. This organ is sometimes found like a spike, racemus, or panicle, and from these it takes its name.

The terms appropriated to it are the following :—

1. *Spiked* (spicatus), having the appearance of a spike.—2. *Racemelike* (racemosus), forming a raceme.—3. *Paniculated* (paniculata), having the form of a panicle.

The CATKIN (amentum, or julus), is a long and always simple stem, which is thickly covered with scales, under which are the flowers, or their essential parts.

Examples of this are found in the willows (salices), hazel (Corylus avellana), hornbeam (carpinus), &c.

1. *Cylindrical* (cylindricum), which is equally thick above or below.—2. *Attenuated* (attenuatum), which grows thinner and thinner to the point.—3. *Slender* (gracile), which is long, but has few scales, and also is slender in proportion to its length.—4. *Ovate* (ovatum), which is thick below and around, but grows gradually more slender to the point.

The accessory leaves of the inflorescence are the bracteæ, of which the spatha, and the involucrum are varieties.

The BRACTEÆ are small leaves, placed above the articulation of the inflorescence, near or between the flowers, and in general are of a different shape and colour from the other leaves. They are subject to many variations of figure, duration, &c.; the terms to express which are the same as are applied to leaves under similar circumstances.

The SPATHA and the INVOLUCRUM differ from bracteæ in being situated immediately below the articulation of the inflorescence with the plant. They are both subject to several variations of form, which are designated by particular names.

The spatha is,

1. *Univalve* (univalvis), when it consists but of one leaf; as in Arum maculatum.—2. *Bivalve* (bivalvis), when two leaves stand opposite each other, as in Stratiotes.—3. *Halved* (dimidiata), when the flowers are covered on one side only.—4. *Permanent* (persistens), when it remains unchanged till the fruit appears.

The INVOLUCRUM consists of several leaves, surrounding one or several flowers. It is chiefly known in umbelliferous plants, and in compound flowers. In the former the terms employed do not differ from those used for other parts of a plant; in the latter it is altogether of another kind, and requires a particular description.

The common CALYX, common PERIANTHIUM, or ANTHODIUM, as it is sometimes called, is an involucrum, which contains a great number of flowers, in such a manner as that these flowers appear to form but one; as in the dandelion (Leontodon taraxacum), blue bottle (Centaurea cyanus), sun flower (Helianthus annuus), &c. The kinds are,

1. *One-leaved* (monophyllum), that consists of but one leaf, united at the base, but divided at top.—2. *Many-leaved* (polyphillum), that is compounded of several leaves. —3. *Simple* (simplex), when the flowers are surrounded with a single row of leaves.—4. *Equal* (æquale), when in a simple perianth the leaves are of equal length.—5. *Scaly or imbricated* (squamosum or imbricatum), when the common perianth consists of closely imbricated foliola.—6. *Squamose* (squamosum), when the foliola are bent back at the point.—7. *Scariose* (scariosum), when the foliola are hard and dry: this is found in Centaurea glastifolia.—8. *Fringed* (ciliatum), when the margins of the foliola are beset with short bristles of equal length.—9.

Muricated (muricatum), when the margins of the foliola are set with short stiff prickles.—10. *Thorny* (spinosum), when each leafet is provided with a horn: these are either simple thorns (spinæ simplices), or branched (ramosæ).—11. *Turbinated* (turbinatum), when the perianth has quite the figure of a top.—12. *Spherical* (globosum), when it has the form of a perfect sphere.—13. *Hemispherical* (hemisphæricum), when it is round below and flat above.—14. *Cylindrical* (cylindricum), when the perianth is round and long, as thick above as below.—15. *Flat* (planum), when the foliola of the perianth are spread out quite flat.—16. *Doubled or calyculated* (auctum or calyculatum), when at the base of the common perianth there is another row of foliola, that appear to form another involucrum; as in dandelion, Leontodom Taraxacum.

The FLOWER is the part immediately terminating the twigs or branches of the inflorescence, and containing the commencement of the fruit. Its parts are the *Calyx*, the *Corolla*, the *Stamens*, and the *Pistillum*; besides which must be noticed the *Discus*.

When the calyx and corolla are so confounded as not to be capable of being distinguished, they are called PERIANTHIUM; as in Butomus.

The CALYX immediately encloses the flower. It is, 1. *Abiding* (persistens),remaining after the flower falls off; as in the henbane, Hyoscyamus niger.—2. *Deciduous* (deciduus), that falls off at the same time with the flower; as in the lime tree, Tilia Europæa.—3. *Withering* (marcescens), that withers after the flower, but still remains for some time, and at last drops off; as in the apricot, Prunus Armeniaca. —4. *Caducous* (caducus), that falls off before the flower; as in the poppy, Papaver somniferum.—5. *Simple* (simplex). —6. *Double* (doublex), when a double calyx encloses the

flower; as the strawberry, Fragaria vesca; mallow, Malva rotundifolia.—7. *One-leafed* (monophyllous), when the calyx consists of one leaf, that is, it may be divided into equal or unequal laciniæ, but all of them are connected at the base. —8. *Two, three, four, five-leafed,* di-tri-tetra-penta, &c. phyllous, many-leaved (polyphyllous), when it consists of two or more foliola.—9. *Dentated* (dentatus), when it has at the margin short segments or indentations, but which are not deeper at most than the fourth part of the whole calyx. According to the number of these segments the calyx is bi, tri, quadri, quinque, &c. or multidentatus, with two, three, four, five, or many segments.—10. *Cleft* (fissus), when the calyx is divided into laciniæ, but which reach only to the middle. It is often bi-tri-quadri-multifidus. —11. *Parted* (partitus), when it is divided down to the base. These divisions are also named according to their number, as bi-tri-quadri-&c. multipartitus.—12. *Labiated or bilabiated* (labiatus or bilabiatus), when it is deeply divided into two laciniæ, both of which are dentated; as in garden sage, Salvia officinalis.—13. *Entire* (integer), when a monophyllous calyx is short, round at the base, and entire on the margin.—14. *Urceolated* (urceolatus), when a monophyllous calyx is short, round at the base, and entire on the margin.—15. *Shut* (clausus), when a polyphyllous, or divided calyx, applies itself closely to the corolla.—16. *Tubular* (tubulosus), when a divided cleft, or indented calyx, at its origin is cylindrical, and forms a tube.—17. *Spreading* (patens), when, in a monophyllous or polyphyllous calyx, the foliola or laciniæ stand quite open.—18. *Reflected* (reflexus), when either the segments, or laciniæ in monophyllous calyxes, or the foliola in polyphyllous, are bent back.—19. *Inflated* (inflatus), when the calyx is hollow, and bellies out.—20. *Abbreviated* (abbreviatus), when the calyx is much shorter than the corolla.—

21. *Coloured* (coloratus), when the calyx is of another colour than green.

The Corulla is the envelope, or small leaves enclosed by the calyx, surrounding the interior parts of the flower, of a more delicate structure than the calyx, and of another colour than green. It consists either of one piece or of several; the first called a monopetalous corolla (corolla monopetala), the last polypetalous (corolla polypetala). The pieces it consists of are called petals (petala).

The *monopetalous corolla* is that which consists of but one piece, which, however, may be divided into segments, but which must always be entire at the base. The following are varieties of this corolla:—

1. *Tubular* (tubulosa), that consists of a single piece, hollow and of equal thickness. The small corolla or floret, which is found included in a common perianthium, is also called tubular, although it sometimes departs from this form.—2. *Club-shaped* (clavata), which forms a tube, growing gradually wider upwards, and narrower at the aperture. —3. *Spherical* (globosa), which is narrow above and below, and wide in the middle.—4. *Bell-shaped* (campanulata), that grows gradually wider at the mouth, so that it has nearly the appearance of a bell.—5. *Cup-shaped* (cyathiformis), when a cylindrical tube grows gradually wider from below upwards, but the margin is upright, and not bent back or contracted.—6. *Urceolated* (urceolata), when a short cylindrical tube extends itself into a wide surface, the margin of which is erect.—7. *Funnel-shaped* (infundibuliformis), when the tube of the corolla grows gradually wide, above that is obversely conical, but the rim pretty flat and turned outwards.—8. *Salver-shaped* (hypocrateriformis), when the tube of the corolla is perfectly cylindrical, but very long, and the rim forms a broad expansion; as in Phlox.—9. *Wheel-shaped* (rotata), when a cylindrical tube is very short,

nearly shorter than the calyx, sometimes hardly perceptible, and its margin is quite flat. It is almost the same with the foregoing, only the tube is very short; as in shepherd's club, Verbascum.—10. *Tongue-shaped* (ligulata), when the tube is not long, suddenly ceases, and ends in an oblong expansion; as in the Aristolochia clematitis, and in some flowers that are contained in a common perianthium.—11. *Difform* (difformis), when the tube gradually becomes wider above, and is divided into unequal lobes; as in some corollas that are included in a common perianthium, *e. g.* the blue bottle, Centaurea cyanus.—12. *Ringent* (ringens), when the margin of a tubular corolla is divided into two parts, of which the upper part is arched, the under oblong, and has some resemblance to the open mouth of an animal; as in sage, Salvia officinalis.—13. *Masked* (personata), when both segments of the ringent flower are closely pressed together; as in snap-dragon, Antirrhinum majus.—14. *Bilabiate* (bilabiata), when the corolla has two segments or lips, which lie over against each other, and which are themselves often laciniated or cleft.—15. *One-lipped* (unilabiata), when in a ringent, personate, &c. corolla, the upper or under lip is wanting, as in Teucrium.

The kinds of the *many-petalled corolla* (corolla polypetala) are,

1. *Roselike* (rosacea), when petals which are pretty round, and at their base have no unguis, form a corolla.—2. *Mallowlike* (malvacea), when five petals, which at the base are considerably attenuated, so unite below that they appear to be monopetalous.—3. *Cross-like* (cruciata), when four petals, which are very much produced at their base, stand opposite to one another; as in Sinapis alba, Brassica oleracea, viridis, &c.—4. *Pink* (caryophyllacea), when the petals at their base are much elongated, and stand in a monophyllous calyx; as in Dianthus caryophyllus, &c.

5. *Lilly-like* (liliacea), when there are six petals, but no calyx. In some there are only three, in others they form a tube at the bottom. This makes the idea somewhat indefinite; but it ought to be remarked that this kind of corolla never has a calyx, and that it is only proper to the lilies.—6. *Two, three, four, five, many petalled* (di-tri-tetra-penta-&c. polypetala), thus the corolla is denominated according to the number of the petals.—7. *Papilionaceous* (papilionacea), when four petals differing in figure stand together; to these petals the following names have been given (for instances, examine the flowers of the common pea, pisum sativum, or vetch, vicia sativa):—*a.* The *standard* (vexillum) is the uppermost petal, which is commonly the largest, and is somewhat concave.—*b.* The *two wings* (alæ) are the two petals, which stand under the vexillum, and opposite to each other on each side.—*c.* The *keel* (carina) is the undermost petal: it is hollow, and stands under the vexillum, and opposite to it, and contains the ovary, with the stamina and pistillum.—8. *Orchideous* (orchidea), is a corolla, composed of five petals, of which the undermost is long, and sometimes cleft; the other four are arched, and bent towards one another.—9. *Irregular* (irregularis), consisting of four or more petals, which are of different lengths and inclination, so that they do not come under the description of the other kinds.

A single division of the corolla, as we have observed, is called a PETAL (petalum); when this is plain, the upper part is called lamina, the under part unguis.

The particular parts of the corolla have, besides, appropriate names. The following are those of the monopetalous corolla:—

1. The *tube* (tubus), of a monopetalous corolla is the under part, which is hollow, and in general of equal thickness. All flowers with this kind of corolla have a tube

except the bell-shaped, and sometimes the wheel-shaped.—2. The *border* (limbus), is the opening of the corolla, especially when it is bent back. The limbus is often dentated or deeply divided, and the divisions are called—3. *Segments or lobes* (laciniæ or lobi), and they are denominated according to their figure, number, and situation.—4. The *helmet* (galea) is the upper arched lacinia of a ringent or masked corolla, which is further denominated according to its situation, figure, and segments or laciniæ.—5. The *gape* (rictus) is, in ringent flowers, the space between the two extremities of the helmet and the under lip.—6. The *throat* (faux), in a monopetalous and ringent corolla, is the opening of the tube.—7. The *palate* (palatum), in a personate corolla, is the arch of the under lip, which is so elevated as to close the faux.—8. The *labellum* is the under lip of a ringent and personate corolla.—9. The *lips* (labia), in the bilabiate and unilabiate flowers, are two divisions, the one called the upper lip (labium superius), and the other the under lip (labium inferius). The galea and labellum are likewise by some botanists called lips.

The STAMENS are the male organs of the plant, and are seated between the corolla and the ovarium. Their parts are three; the filament, the anther, and the pollen.

The FILAMENT (filamentum) is a longish body, that is destined for the support and elevation of the anther. In its figure it is very various:—

1. *Capillary* (capillare), that is all of equal thickness, and as fine as a hair.—2. *Filiform* (filiforme), like the former, only thicker.—3. *Awl-shaped* (subulatum), which is thicker below than above.—4. *Dilated* (dilatatum), that is so compressed on the sides as to appear broad and leaf-like.—5. *Heart-shaped* (cordatum), the same with the foregoing, but with a margin above and pointed below; as in Mahernia.—6. *Wedge-shaped* (cuneiforme), a dilated filament, that is

pointed below, but cleft above; as in Lotus tetragonolobus. —7. *Loose* (liberum), that is not attached to any other filament.—8. *Connate* (connatum), when several grow together, forming a cylinder; as in the mallow, Malva.—9. *Bifid* (bifidum), when a filament is divided into two parts.—10. *Multifid or branched* (multifidum or ramosum), when it is divided into many branches; as in Carolinea princeps.—11. *Jointed* (articulatum), when the filament has a moveable joint; as in sage, Salvia officinalis.—12. *Connivent* (connivens), when several filaments bend towards one another at their points.—13. *Incurved* (incurvum), that has a bend like a bow.—14. *Declined* (declinatum), when several filaments do not stand erect, but by degrees, without describing a large curve, bend towards the upper or under part of the flower; as in Pyrola.—15. *Hairy* (pilosum), set with fine hairs.—16. *Equal* (æquale), that are all of equal length.—17. *Unequal* (inæquale), when some are long and some short.

The ANTHER (anthera) is a hollow cellular body that contains a quantity of pollen. Its kinds are the following:—

1. *Oblong* (oblonga), which is long and pointed at both ends.—2. *Linear* (linearis), that is long and flat, but all of equal breadth.—3. *Spherical* (globosa), when perfectly round. —4. *Kidney-shaped* (reniformis), that is, spherical on one side, but concave on the other; as in ground-ivy, Glechoma hederacea, foxglove, Digitalis purpurea, &c.—5. *Doubled* (didyma), when two seem to be joined together.—6. *Arrow-shaped* (sagittata), that has a long point, and is cleft at the base into two parts.—7. *Bifid* (bifida), that is, linear, but cleft above and below, as in the grasses.—8. *Peltated* (peltata), that is, circular, flat on both sides, and attached by the middle to the filament; as in the yew, Taxus baccata.—9. *Dentated* (dentata), that on the margin has dents or indentations; as in the yew, Taxus baccata.—10. *Hairy* (pilosa), that is, covered with hair; as in the dead nettle, Lamium

album.—11. *Two-horned* (bicornis), which has at its apex two subulate prolongations; as in Pyrola, Arbutus, Erica, &c.—12. *Awned* (aristata), that at the base has two bristle-shaped appendages; as in Erica.—13. *Crested* (cristata), when two cartilaginous points are set on the sides or on the base; as in some heaths, Ericæ.—14. *Awnless* (mutica), when it has neither awn nor crest. It is the opposite of No. 12, 13.—15. *Angulated* (angulata), that has several deep furrows that form four or more angles.—16. *Bilocular* (bilocularis), when the anther is divided by a partition into two parts or cells.—17. *Unilocular* (unilocularis), when there is but one cell or cavity in the anther.—18. *Bursting at the side* (latere dehiscens).—19. *Bursting at the point* (apice dehiscens).—20. *Free* (libera), that is not attached to another anther.—21. *Connate* (connata), when several grow together, forming a tube.—22. *Erect* (erecta), standing with its base straight on the point of the filament.—23. *Incumbent* (incumbens), that is perpendicularly, or even obliquely attached to the filament.—24. *Lateral* (lateralis), that is attached, by its side, to the point of the filament.—25. *Moveable* (versatilis), when Nos. 23 and 24 are so slightly attached to the filament that the least motion agitates the anther.—26. *Adnate* (adnata), when the anther is closely attached to both sides of the point of the filament.—27. *Sitting* (sessilis), that has no filament.

The Pollen is a powder, that appears in the form of the finest dust. In the microscope its figure is various, being hollow, and filled with a fertilizing moisture.

The Pistillum is the organ which occupies the centre of the flower, and which finally terminates the developement of the inflorescence, just as a bud terminates the progress of the foliage. Hence it has been philosophically considered as a bud in a particular state. It consists of three parts; the ovarium, the style, and the stigma.

The Ovarium is the undermost part of the pistillum, and is the rudiment of the future fruit. The number of ovaria is very various; they are reckoned from six to eight, after which they are said to be several or many ovaria. The figure is also very different. The principal kinds are:—

1. *Sitting* (sessile), that has no foot-stalk.—2. *Pedicelled* (pedicellatum), furnished with a foot-stalk.—3. *Superior* (superum), when the germen is encircled by the calyx, or, when this is wanting, by the other parts of the flower.—4. *Inferior* (inferum), when the ovary is situated under the calyx, or, when this is wanting, under the corolla.

The Style (stylus) is seated upon the germen, and resembles a small column or stalk. The kinds of it are the following:—

1. *Hair-like* (capillaris), that is very slender, and of equal thickness.—2. *Bristle-like* (setaceous), as slender as the former, but somewhat thicker at the base.—3. *Thread-like* (filiformis), which is long and round.—4. *Awl-shaped* (subulatus), thick below, above sharp pointed.—5. *Gross* (crassus), that is very thick and short.—6. *Club-shaped* (clavatus), thicker above than below.—7. *Two, three, four, &c. multifid* (bi-tri-quadri-&c., multifidus), cleft in a determined manner.—8. *Dichotomous* (dichotomus), divided into two parts, which are again divided at the points.—9. *Terminal* (terminalis), which stands on the top of the germen.—10. *Lateral* (lateralis), attached to the inside of the germen.—11. *Erect* (rectus), which stands straight up.—12. *Declined* (declinatus), that inclines towards the side.—13. *Abiding* (persistens), that does not fall off.—14. *Withering* (marcescens), that withers, and afterwards falls off.—15. *Deciduous* (deciduus), that falls off immediately after impregnation.

The number of the styles must likewise be accurately counted; for there is often more than one style to one

germen, and this must be particularly observed. The length of the style, whether longer or shorter than the stamina, is also to be mentioned.

The STIGMA means the top of the style. The kinds of it are as follows :—

1. *Pointed* (acutum), when it has a sharp point.—2. *Blunt* (obtusum), when it forms a blunt point.—3. *Oblong* (oblongum), when it is thick and elongated.—4. *Club-shaped* (clavatum), resembling a small club.—5. *Spherical* (globosum), forming a perfectly round globe.—6. *Capitate* (capitatum), a hemisphere, the under side flat.—7. *Emarginated* (emarginatum), when the last-mentioned kind has a notch in it.—8. *Peltated* (peltatum), that is formed like a shield.—9. *Uncinated* (uncinatum), hooked at the point.—10. *Angular* (angulosum), when it is furnished with close and deep furrows, which occasion projecting angles.—11. *Three-lobed* (trilobum), which consists of three round bodies, somewhat pressed flat.—12. *Dentated* (dentatum), when it is set with fine teeth.—13. *Cruciform* (cruciforme), when it is divided into four parts, of which two are always opposite to each other.—14. *Pencil-like* (pencilliforme), consisting of a number of short, thick, close, fleshy fibres, in form of a pencil.—15. *Hollow* (concavum), when it is of a globular or longish form, but quite hollow, as in the violet.—16. *Petal-like* (petaloïdeum), when it has the appearance of a petal; as in Iris.—17. *Two, three, and multifid* (bi, tri, &c. multifidum).—18. *Bent back* (revolutum), when the points of a bifid or multifid stigma are rolled back outwards.—19. *Bent in* (convolutum), when the points of a divided stigma are rolled inwards.—20. *Spiral* (spirale), when a multifid stigma is rolled up like the spring of a watch.—21. *Plumose* (plumosum), when the stigma is set with fine hairs on both sides, so as to have the appearance of a feather; as in the grasses.—22. *Hairy* (pubescens), that is set with short white hairs.—23.

Lateral (laterale), which is situated on the side of the stylus or of the germen.—24. *Sitting* (sessile), which, when there is no style, rests on the germen.

The Stigma, properly speaking, consists of a number of inhaling tubercles, which are not always visible without a magnifier. In the Mirabilis Jalapa they are to be seen most distinctly.

The Discus is a fleshy ring, surrounding the pistillum at its base; and is one of the various things which Linnæus indiscriminately named nectary. It generally exists in the form of a ring, or annulus, into which the stamens are inserted, or not, as the case may be. Occasionally it is so much enlarged as to enclose the pistillum in part, as in Pæonia Moutan, or entirely, as in Nelumbiam, when it constitutes the principal part of the fruit.

The Fruit is the perfection of vegetation. It is by this part that all plants are perpetuated; and with this, in many plants, existence terminates. In common language, the term is applied to such as are fleshy and eatable; but, in scientific language, it signifies the fecundated ovarium in a ripe state; and, in a more extended sense, the aggregation of several ripe ovaria, even belonging to different flowers.

The essential parts of a fruit are the pericarp and the seed.

The Pericarp is the covering of the seed, and the most external part of the fruit. It is terminated at the one end by the vestiges of the style, and at the other by the receptacle or peduncle. It consists of three parts: 1. the *epicarp*, which is the skin or outer coat; 2. the *sarcocarp*, which constitutes the flesh in fleshy fruits, and is the substance immediately covered by the epicarp; 3. the *endocarp*, which is the inner lining of the fruit, and the same as Gærtner has called putamen.

The pericarp is always present in the ovarium, but sometimes is obliterated in the fruit. It is sometimes internally divided by partitions, which are called dissepiments, and

which bear on some part of their surface, generally at the inner angle, a fleshy or spongy mass, which is called the placenta, and on which the seeds are placed.

The pericarp varies in the mode of dehiscence, in degree of combination, in texture, and in relation to the perianthium. From variations in these modifications, fruits may be divided into five classes, and thirty-nine genera, disposed in the following manner:—

SECT. 1. SIMPLE.

* SUPERIOR.	* INFERIOR.
1. † Unilocular, or simple.	1. † Unilocular, or simple.
§ *Indehiscent.*	§ *Indehiscent.*
1. Utriculus.	11. Stephanæum.
2. Achenium.	12. Arcesthida.
3. Cariopsis.	
4. Catoclesium.	
5. Scleranthum.	
6. Samara.	
7. Glans.	
8. Nux.	
9. Drupa.	
10. Lomentum.	
§ *Dehiscent.*	
13. Legumen.	
14. Folliculus.	
2. † Plurilocular, or compound.	† Plurilocular, or compound.
§ *Indehiscent.*	§ *Indehiscent.*
15. Nuculanium.	20. Polyachenium.
16. Bacca.	21. Pomum.
17. Hesperidium.	22. Pepo.
18. Carcerulus.	23. Acrosarcum.
19. Sterigmum.	24. Balausta.
§ *Dehiscent.*	§ *Dehiscent.*
25. Siliqua.	30. Diplostegia.
26. Silicula.	
27. Pyxidium.	
28. Capsula.	
29. Regmatus.	

* SUPERIOR.	* INFERIOR.
3. † Gynobasic,	
31. Microbasis.	
32. Sarcobasis.	
4. † Multiplex.	
33. Acinos.	
34. Etærio.	
35. Amalthea.	
36. Asimina.	
5. † Aggregate.	
37. Sorosus.	
38. Strobilus.	
39. Ananassa.	

The foregoing are distinguished among themselves by the following additional characters:—

1. *Utriculus.* Pericarp bladdery, monospermous, not adhering to the seed. Eleusine.

2. *Achenium.* Pericarp coriaceous, monospermous, or oligospermous, not adhering to the seed. Rosa. Thecidium of Mirbel is a variety.

3. *Çariopsis.* Pericarp usually thin, monospermous, always adhering closely to the seed and inseparable from it. Grasses. Also called Cerio.

4. *Cataclesium.* Pericarp coriaceous, monospermous, covered by the caylyx, which does not adhere to it, but which is much enlarged. Salsola. To this must be referred Sacellus and Sphalerocarpium.

5. *Scleranthum.* Pericarp thin, monospermous, covered by the indurated base of the calyx or perianthium. Mirabilis. Also called Dyclesium.

6. *Samara.* Pericarp coriaceous, oligospermous, with a long wing at its back. Acer. This fruit is either compound or simple, but always unilocular in its divisions.

7. *Glans.* Pericarp coriaceous, mono-dispermous, covered at the base by an indurated involucre, which takes the name of cup. Quercus, Laurus. Also called Calybio.

8. *Nux.* Pericarp woody, mono-dispermous, covered at the base by a foliaceous involucre. Peculiar to Corylus. The term is applied by many authors to nearly all the hard fruits, which have only one or two seeds. Called also Nucula by Desvaux: but that term is employed by some botanists for the Achenium.

9. *Drupa.* Sarcocarp fleshy; endocarp bony and separable, mono-dispermous. Amygdalus. From this Tryma is not distinguishable.

10. *Lomentum.* Pericarp polyspermous, contracted at the interval between each seed, and separating there into joints. A form of the Legumen. Hedysarum.

11. *Stephanæum.* Pericarp inseparable from the calyx, and of variable consistence, monospermous. Compositæ. Also called Cypsela.

12. *Arcesthida.* Spherical monospermous, formed by the cohesion of several fleshy scales. Juniperus.

13. *Legumen.* Polyspermous, two-valved, one-celled. Vicia.

14. *Folliculus.* Polyspermous, one-valved, often spuriously two-celled. Pæonia.

15. *Nuculanium.* Sarcocarp fleshy, endocarp bony, often confluent. Verbenaceæ. Differs from drupa in being compound. Also called Pyrena and Nucula.

16. *Bacca.* Pericarp pulpy, the cells obliterated, the seeds nidulant in the pulp, and having no distinct mode of connexion with the pericarp when ripe. Jasminum. This term is often applied very vaguely.

17. *Hesperidium.* Sarcocarp coriaceous, endocarp and placentas fleshy or pulpy, seeds nidulant, cells distinct. Citrus. Also called Aurantium.

18. *Carcerulus.* Pericarp dry, cells not more than five, within confluent or distinct. Tilia.

19. *Sterigmum.* Pericarp dry, cells very numerous, more

than five, occasionally dehiscent slightly. This is hardly different from the last. Malva.

20. *Polyachenium.* Pericarp and calyx inseparable, dry, cells opposite, separating from the top of the common axis. Umbelliferæ. Called Carpodelium when the cells exceed two, and the pericarp is slightly fleshy; as in Aralia.

21. *Pomum.* Pericarp and calyx inseparable, forming a fleshy mass, endocarp variable in texture, never pulpy. Pyrus.

22. *Pepo.* Pericarp and calyx inseparable, fleshy, endocarp pulpy, seeds parietal, when ripe nidulent in pulp. Cucumis. Also named Peponida.

23. *Acrosarcum.* The same as bacca, but the calyx adheres to the pericarpium. An inferior berry. Ribes.

24. *Balausta.* Pericarp coriaceous, enclosing a number of irregular cells, containing seeds with a pulpy testa. Punica. An inferior Hesperidium.

25. *Siliqua.* Pericarp linear, polyspermous, two-valved, valves separating from the face of the dissepiment. Brassica.

26. *Silicula.* Pericarp round or oblong, oligospermous, two-valved, valves separating from the face of the dissepiment. Draba.

27. *Pyxidium.* Pericarp polyspermous, separating into two halves by a circular horizontal separation, so that the valves resemble two hemispheres. Anagallis. The lower valve is called amphora, the upper operculum.

28. *Capsula.* Pericarp polyspermous, separating vertically into valves. Silene.

29. *Regmatus.* Pericarp separating with elasticity into mono or dispermous cells (cocci), which are pendulous from the apex of a common axis, and are more or less dehiscent. Euphorbia. Scarcely distinct from polyachenium. Also called Cremocarpium.

30. *Diplostegia.* Pericarp polyspermous, variable in con-

sistence, inseparable from the calyx, dehiscing in various manners. May be considered an inferior capsule. Hydrangea.

31. *Microbasis*. Pericarpia several, monospermous, indehiscent, dry, attached by the base to a common style, and seated on a receptacle called the gynobase. Libiatæ. The naked seeds of Linnæus.

32. *Sarcobasis*. A mere variety of the last, from which it scarcely differs, except in having fleshy pericarpia upon an enlarged fleshy gynobase. Ochna.

33. *Acinus*. Drupes, very small and numerous, arranged on an elongated receptacle, and when becoming confluent when ripe, having a membraneous covering. Fragaria. This is the Syncarpa of Richard, but not of others. Polysecus seems to be not distinguishable from this.

34. *Etœrio*. Pericarpia several, formed from distinct ovaries, and arranged around an imaginary centre, generally polyspermous and dehiscent. Sempervivum. This is also the Plopocarpium of Desvaux.

35. *Amalthea*. Composed of several achenia, enclosed within the cavity of a coriaceous calyx. Rosa. Also called Cynarrhodon.

36. *Asimina*. Ovaries numerous, bacciform, one-celled, produced from a single flower, and united in a solid fleshy fruit. Anona. Very near the acinus, from which it differs chiefly in size, and in having its outer coat coriaceous, not membranous.

37. *Sorosus*. Pericarpia very numerous, dry, generally achenia, arranged upon a fleshy receptacle, which is urceolate, and enclosed at its mouth. Ficus. Also called Syconus.

38. *Strobilus*. Pericarpia many, indehiscent, unilocular, monospermous, each enclosed in an indurated scale. Scales imbricated, forming by their cohesion a hard irregular cone. Pinus. Of this Galbalus is a mere variety.

39. *Ananassa.* Pericarpia many, indehiscent, polyspermous, cohering with the calyx, and seated each in the axilla of a fleshy scale, which coheres with them, and in maturity forms a solid fleshy mass. Bromelia.

The Seed is that part of the fruit which is enclosed in the pericarp, and which contains the rudiments of the future plant. It consists of three distinct parts; the *testa,* the *albumen,* and the *embryo.*

The Testa is the external covering or coat of the seed. Some writers distinguish it into three parts; calling the external skin the testa, the intermediate substance the sarcodermis, and the interior pellicle the endopleura.

The scar upon the testa, which indicates the point by which the seed was attached to the placenta, is called the *hilum.* On this space two distinct points are observable, viz. the *omphalodium,* a protuberant point, situated for the most part in the middle of the hilum, and indicating the point by which the nourishing vessels have passed; and the *micropyle* or *foramen,* which is a point situated by the side of the umbilicus, and is supposed by some authors to mark the spot by which the fecundating vessels have terminated; but is declared by Mr. Brown to indicate a perforation existing in the ovulum, through which a fecundating aura is communicated to the embryo, and which never has any vascular connexion with the pericarpium.

Chalaza is a point marked upon the endopleura, and indicates the place where the umbilical cord pierces it. This point is ordinarily under the hilum; sometimes it is at a distance from it, in which case it is connected with the hilum by a bundle of vessels called the raphe.

Strophiolæ are callous or fungous lumps, generally found about the hilum of certain seeds; sometimes they are otherwise stationed.

The Kernel is the name given to all the parts of the seed included under the testa.

The Albumen is that part of the kernel which surrounds the embryo, which never adheres to it, which possesses no vascular organization, and which is of various degrees of texture, being either fleshy, or corneous, or ligneous, or feculent, or granular, &c.

The Embryo is that part of the kernel which exists in all fecundated seeds, and which is destined to reproduce the plant which bore it. It is divided into three parts, viz. the radicle, the plumula, and the cotyledons.

The Radicle is that part of the embryo which becomes the root, and which, in the ripe seed, is always directed away from the chalaza.

The Plumula is the part which is destined to be the stem, and which is situated at the base of the cotyledons.

The Cotyledons are the organs which adhere to the plumula, and which become the first leaves of the plant. Their purpose is to supply nourishment to the young plant, until it shall be in a condition to elaborate food for itself.

Linnæan System.

The classes of this system depend either upon the number, proportion, or insertion of the stamens or male organs, as explained in the following table :—

TABLE OF THE CLASSES.

Plants celebrate their nuptials

- Either Publicly, i. e. have visible flowers :
  - Plants, which have visible flowers, are either
  - Monoclinia, males and females in the same bed : i. e. The flowers are all hermaphrodite :
    - Among the Monoclinia, there is either
    - Diffinitas, the males or stamina unconnected with each other :
      - In these the stamina are either
      - *Indifferentissima*, i. e. the males have no fixed proportion as to length :
        1. Monandria, i. e. one male or stamen in an hermaphrodite flower.
        2. Diandria, . two males or stamina.
        3. Triandria, . three males.
        4. Tetrandria, . four males.
        5. Pentandria, . five males.
        6. Hexandria, . six males.
        7. Heptandria, . seven males.
        8. Octandria, . eight males.
        9. Enneandria, . nine males.
        10. Decandria, . ten males.
        11. Dodecandria, . twelve males.
        12. Icosandria, . twenty or more males inserted into the calyx.
        13. Polyandria, . all above twenty males inserted into the receptacle.
      - Or *Subordinata*, two of the males are uniformly shorter than the rest.
        14. Didynamia, . four males, two long and two short.
        15. Tetradynamia, six males, four long and two short.
    - Or Affinitas, the stamina either connected to each other, or to the pistillum.
      16. Monadelphia, the stamina united into one body by the filaments.
      17. Diadelphia, the stamina united into two bodies by the filaments.
      18. Poladelphia, the stamina united into three or more bodies by the filaments.
      19. Syngenesia, the stamina united into a cylindrical form by the antheræ.
      20. Gynandria, the stamina inserted into the pistillum.
  - Or Diclinia, males and females in separate beds, i. e. plants tha have stamina and pistilla in different flowers in the same species.
    21. Monœcia, male and female flowers distinct in the same plant.
    22. Diœcia, males and females in different plants, of the same species.
    23. Polygamia, male, female, and hermaphrodite flowers in the same or different plants.
- Or Clandestinely, i. e. have their parts of fructification either invisible or not distinct.
  24. Cryptogamia, the flowers invisible, so that they cannot be ranked according to the parts of fructification, or distinctly described.

The orders of the first thirteen classes are distinguished by the number of the styles; of the fourteenth by the nature of the fruit, which is what the Linnæan botanists call 'naked seeds' in the first, and 'covered in the second; of the fifteenth by the length of the pericarpium; of the sixteenth, seventeenth, eighteenth, twentieth, twenty-first, and twenty-second, by the number or situation of the stamens; of the nineteenth by the relative sexes of the florets of the disk, and ray of the capituli; of the twenty-third by the sex of the flowers; and of the twenty-fourth by such general characters as are used in discriminating genera. The following is a

TABLE OF THE ORDERS.

CLASSES.	NUMBER AND NAMES OF THE ORDERS.	
1. MONANDRIA	2	Monogynia, Digynia.
2. DIANDRIA	3	Monogynia, Digynia, Trigynia.
3. TRIANDRIA	3	Monogynia, Digynia, Trigynia.
4. TETRANDRIA	3	Monogynia, Digynia, Tetragynia.
5. PENTANDRIA	6	Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Polygynia.
6. HEXANDRIA	5	Monogynia, Digynia, Trigynia, Tetragynia, Polygynia.
7. HEPTANDRIA	4	Monogynia, Digynia, Tetragynia, Heptagynia.
8. OCTANDRIA	4	Monogynia, Digynia, Trigynia, Tetragynia.
9. ENNEANDRIA	3	Monogynia, Trigynia, Hexagynia.
10. DECANDRIA	5	Monogynia, Digynia, Trigynia, Pentagynia, Decagynia.
11. DODECANDRIA	5	Monogynia, Digynia, Trigynia, Pentagynia, Dodecagynia.
12. ICOSANDRIA	5	Monogynia, Digynia, Trigynia, Pentagynia, Polygynia.

CLASSES.	NUMBER AND NAMES OF THE ORDERS.
13. POLYANDRIA	7 Monogynia, Digynia, Trigynia, Tetragynia, Pentagynia, Hexagynia, Polygynia.
14. DIDYNAMIA	2 Gymnospermia, Angiospermia.
15. TETRADYNAMIA	2 Siliculosa, Siliquosa.
16. MONADELPHIA	8 Triandria, Pentandria, Octandria, Enneandria, Decandria, Endecandria, Dodecandria, Polyandria.
17. DIADELPHIA	4 Pentandria, Hexandria, Octandria, Decandria.
18. POLYADELPHIA	4 Pentandria, Dodecandria, Icosandria, Polyandria.
19. SYNGENESIA	6 Polygamia æqualis, Polygamia superflua, Polygamia frustranea, Polygamia necessaria, Polygamia segregata, Monogamia.
20. GYNANDRIA	2 Monandria, Diandria.
21. MONŒCIA	11 Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Heptandria, Polyandria, Monadelphia, Syngenesia, Gynandria.
22. DIŒCIA	15 Monandria, Diandria, Triandria, Tetrandria, Pentandria, Hexandria, Octandria, Enneandria, Decandria, Dodecandria, Icosandria, Polyandria, Monadelphia, Syngenesia, Gynandria.
23. POLYGAMIA	3 Monœcia, Diœcia, Triœcia.
24. CRYPTOGAMIA	4 Filices, Musci, Algæ, Fungi.

This famous system of arrangement which was founded by Linnæus, under the name of the sexual system, and

which for more than half a century was exclusively employ- by a large proportion of the most learned botanists, and which is even now made use of by some of the more venerable existing writers, may be said to have owed its celebrity more to its being the groundwork of the important labours of its inventor, than for any extraordinary inherent merits. A great recommendation with the world has also been its apparent facility and simplicity. The principles upon which this system was founded will be explained hereafter; its application and merits are all that demand attention in this place. As it is entirely and essentially artificial, it must be considered in that point of view only.

It is obvious that the only merits which an artificial system of arrangement can possess, must be extreme facility and precision of application; and that it will be found defective in exactly the degree in which these qualities are absent. Now, notwithstanding the simplicity of the organs upon which the Linnæan arrangement depends, it is notorious, that it is continually necessary to leave them out of consideration in determining the locality of plants. The species, for example, of a genus vary or differ in the number of their stamens; that genus therefore ought to be found in as many different classes as there is variation or difference of this kind; the species differ or vary in the number of their styles: such a genus would be referrible to as many different orders as there are variations of that nature. These differences exist, not only among species of the same genus, but even in flowers of the same individual: whence cases might be found of particular plants, which belong at the same time to several classes and orders of the system. Can any thing be more objectionable to its use than this fact? and instances of such difficulties are neither few nor uncommon. Another objection to the

sexual system is, that no information is gained by its use, and that after employing it for the whole of a life, not a single idea is acquired beyond the half dozen with which it was necessary to set out; the consequence of which has been a misconception of the nature and analogies of the organs of plants, and a general ignorance of the affinities by which individuals are related, a thorough knowledge of which is absolutely indispensable to any systematic writer. These points are abundantly sufficient to show the inferiority of Linnæus' celebrated system to the praises of his admirers, and to explain the cause of its almost universal disuse at the present day.

The natural method, as it is called, has now, however, so entirely superseded the sexual system, and has become so much more facile than it formerly was, that the utility of any artificial system whatever may now be doubted. This celebrated system is generally said to have taken its rise in France, with Bernard de Jussieu, who in the year 1758 arranged the plants in the Royal Garden of Trianon upon a plan which may be considered the basis of the system in its present state. It is not here, however, an object to enter upon the history of the subject, nor to point out the improvements the method has successively received at the hands of Antoine Laurent de Jussieu, Ventenat, Brown, Mirbel, Richard, and De Candolle. It will be preferable to give a rapid glance at its actual state, principles, and objects.

The great principles upon which the natural system depends, are, that plants ought to be considered with reference to all their organs, forms, and peculiarities, and not with reference to an arbitrary selection of any one of these; that a bond of union exists in all nature, by which individuals approximate to individuals by insensible gradations; and that the true mode of arriving at a knowledge

of the real nature and station of a given object is, by considering it with reference to the points in which it most nearly resembles other objects, which points are called affinities. By this mode of looking at the science, while it becomes necessary to acquire a knowledge of a considerable number of individuals, in order to understand the nature of any single individual, it also follows that the acquisition of this knowledge facilitates in an obvious manner the subsequent investigation of any new subject. For example, a student who is entirely unacquainted with the science, takes up, for the first time in his life, a grass; he examines it, and discovers that it possesses the characters of the extensive natural assemblage called gramineæ, or grasses, and that it belongs to the section of that assemblage called the genus poa. From that time forward he will, from the investigation he must of necessity have instituted, possess an accurate notion of the properties and peculiarities of gramineæ, and, whenever he again meets with a grass, he will know that it is one, and where in the system at once to refer for information respecting it. The same is consequent upon his studies to the end of his career; each new discovery necessarily increasing his knowledge in various directions, and facilitating the making of discoveries to come.

The modes of arrangement, and of analysis, of the natural method are these.

The vegetable kingdom is first divided into three portions, according to the structure of the embryo, and of vegetation, viz. 1. Acotyledones, which have no cotyledons, as other plants, but whose seeds or sporules germinate from any indifferent point of their surface, and whose vegetation is constructed entirely of cellular tissue, without the intermixture of tubular or spiral vessels. 2. Monocotyledones, whose embryo has one cotyledon, rarely none, and which

in that case germinates from a determinate point, and whose vegetation is formed by increase taking place at their centre, not at their circumference. 3. Dicotyledones, which are formed with two cotyledons, and whose vegetation is produced by the gradual superposition of internal layers beneath the bark. This order of arrangement of the three primary groups was used by Jussieu; it is now more frequently inverted, the Acotyledones terminating instead of beginning the series.

Dicotyledones constitute the most extensive part of the vegetable kingdom, and are considered to be in a more perfect state of developement than the two others. They are subdivided, 1. According to the number or absence of their petals, into polypetalous, monopetalous, and apetalous. 2. According to the insertion of their stamens, which is hypogynous or perigynous. 3. According to the adhesion or nonadhesion of their calyx with the ovarium, which is either superior or inferior. 4. According to the position of the stamens with respect to the petals. 5. According to the structure of the fruit. 6. According to the structure of the seed. And 7. According to the modifications of their vegetation, as far as they indicate a corresponding peculiarity in the parts of fructification, which is often the case, and which wonderfully facilitates the acquisition of a knowledge of the natural orders of plants. Thus all Rubiaceæ have opposite entire leaves with intervening stipulæ; all Labiatæ have opposite resinous leaves, without stipulæ; all Leguminosæ have alternate leaves, with stipulæ, and leaflets always jointed with the petiole, and, when compound, furnished with stipulæ at the base of each pair of leaflets.

Monocotyledones are also subdivided according to the above principles, as far as they are applicable to them, but as this group is much more simple in its structure, and less

extensive than dicotyledones, the mode of its division is necessarily different. Its principal section is that of cryptogamiæ, which is characterized by the absence of apparent flowers.

Acotyledones, which contain the plants of the simplest structure, have no sexes, but reproduce themselves by what are called sporules, that is to say, seedlike bodies, which differ from seeds in germinating indifferently from any point of their surface, and in not being the result of sexual contact. This group answers to the Linnæan cryptogamia, excluding filices.

From this statement of the principles upon which the natural system of plants has been contrived, it must be obvious that the difficulties which the advocates of the Linnæan method pretend that it offers to the student do not exist, and that, in fact, the difficulties in the application of the Linnæan method are much greater, as far as the mere student is concerned. In the Linnæan system nothing is learned in the investigation of the name of a plant, except the simple and often very unimportant fact, that its stamens or styles exist in a certain quantity or position; in the natural method, on the contrary, the same process brings the student acquainted, not only with all the characters of that plant which is under his consideration, but also with a comparative knowledge of those plants to which it is allied by nature. In the Linnæan system no step can be advanced till the flower is examined; in the natural method almost any other part of the fructification, and often the foliage or habit of the plant only, will suffice. The Linnæan system produces empirical botany, the natural method scientific botany.

NATURAL SYSTEM.

The following is the arrangement, adopted by the most modern botanists of reputation, of the natural orders of

plants. The basis of it, as we have already stated, is the system of B. Jussieu, published, in 1789, by his nephew, Anthony Jussieu; but so many alterations and additions have been consequent upon the progress of modern science, that it has at present only a distant resemblance to its original.

TABLE OF THE NATURAL ORDERS OF PLANTS, ARRANGED IN A LINEAR SERIES.

I. VASCULAR or COTYLEDONEOUS. (System furnished with cellular tissue, and tubular vessels. Reproductive organs spermaceous).

* DICOTYLEDONEOUS, or EXOGENOUS. (Vessels arranged in concentric layers, of which the youngest are exterior Cotyledons opposite or whorled).

† COMPLETE. Calyx and corolla, both present.

1. POLYPETALOUS.

§ *Petals hypogynous.*

α. Carpella numerous, or stamens opposite the petals.

i. Ranunculaceæ. 1. Clematideæ. 2. Anemoneæ. 3. Ranunculeæ. 4. Helleboreæ. 5. Pæoniaceæ. ii. Dilleniaceæ. 1. Delimeæ. 2. Dilleneæ. iii. Magnoliaceæ. 1. Illicieæ. 2. Magnolieæ. iv. Anonaceæ. v. Menispermaceæ. 1. Lardizabaleæ. 2. Menispermeæ. 3. Schizandreæ. vi. Berberideæ. vii. Podophyllaceæ. 1. Podophylleæ. 2. Hydropeltideæ. viii. Nymphæaceæ. 1. Nelumboneæ. 2. Nymphæeæ.

β. Carpella solitary or consolidated; Placentas parietal.

ix. Papaveraceæ. x. Fumariaceæ. xi. Cruciferæ. 1. Arabideæ. 2. Alyssineæ. 3. Thlaspideæ. 4. Euclidieæ. 5. Anastaticeæ. 6. Cakilineæ. 7. Sisymbreæ. 8. Camelineæ. 9. Lepidineæ. 10. Isatideæ. 11. Archonieæ.

12. Brassiceæ. 13. Velleæ. 14. Psychineæ. 15. Zilleæ. 16. Raphaneæ. 17. Buniadeæ. 18. Erucarieæ. 19. Heliophileæ. 20. Subularieæ. 21. Brachycarpeæ. xii. Capparideæ. 1. Cleomeæ. 2. Cappareæ. xiii. Resedaceæ. xiv. Flacourtianeæ. 1. Patrisieæ. 2. Flacourtieæ. 3. Kiggelarieæ. 4. Erythrospermeæ. xv. Bixineæ. xvi. Cistineæ. xvii. Vialorieæ. 1. Violeæ. 2. Alsodineæ. 3. Sauvageæ. xviii. Droseraceæ. xix. Polygaleæ. xx. Tremandreæ. xxi. Pittosporeæ. xxii. Frankeniaceæ.

γ. Ovary solitary. Placenta central.

xxiii. Caryophylleæ. 1. Sileneæ. 2. Alsineæ. xxiv. Lineæ. xxv. Malvaceæ. xxvi. Byttneriaceæ. 1. Sterculieæ. 2. Byttnerieæ. 3. Lasiopetaleæ. 4. Hermannieæ. 5. Dombeyaceæ. 6. Wallichieæ. xxvii. Tiliaceæ. xxviii. Elæocarpeæ. xxix. Chlenaceæ. xxx. Ternströmiaceæ. 1. Ternströmieæ. 2. Frezierieæ. 3. Sauraveæ. 4. Laplaceæ. 5. Gordonieæ. xxxi. Camellieæ. xxxii. Olacineæ. xxxiii. Aurantiaceæ. xxxiv. Hypericineæ. 1. Vismieæ. 2. Hypericeæ. xxxv. Guttiferæ. 1. Clusieæ. 2. Garcinieæ. 3. Calophylleæ. 4. Symphonieæ. xxxvi. Marcgraaveaceæ. 1. Marcgraavieæ. 2. Noranteæ. xxxvii. Hippocrateaceæ. xxxviii. Erythroxyleæ. xxxix. Malpighiaceæ. 1. Malpighieæ. 2. Hiptageæ 3. Banisterieæ. xl. Acerineæ. xli. Hippocastaneæ. xlii. Rhizboleæ. xliii. Sapindaceæ. 1. Paullinieæ. 2. Sapindeæ. 3. Dodonæaceæ. xliv. Meliaceæ. 1. Melieæ. 2. Trichilieæ. 3. Cedreleæ. xlv. Ampelideæ. 1. Vinifereæ. 2. Leeaceæ. xlvi. Geraniaceæ. xlvii. Tropæoleæ. xlviii. Balsamineæ. xlix. Oxalideæ. l. Zygophylleæ. li. Rutaceæ. 1. Diosmeæ. 2. Cusparieæ. lii. Coriarieæ.

δ. Fruit gynobasic.

liii. Simarubeæ. liv. Ochnaceæ.

§ § *Petals, either separated or united, always periginous.*

lv. Celastrineæ. 1. Staphylæceæ. 2. Euonymeæ. 3. Aquifoliaceæ. lvi. Rhamneæ lvii. Bruniaceæ. lviii. Samydeæ. lix. Homalineæ. lx. Chailletiaceæ. lxi. Aquilarineæ. lxii. Terebintaceæ. 1. Cassuvieæ. 2. Sumachineæ. 3. Spondiaceæ. 4. Burseraceæ. 5. Amyrideæ. 6. Pteleaceæ. 7. Connaraceæ. lxiii. Leguminoseæ. 1. Sophoreæ. 2. Loteæ. 3. Hedysareæ. 4. Vicieæ. 5. Phaseoleæ. 6. Dalbergieæ. 7. Swartzieæ. 8. Mimoseæ. 9. Geoffreæ. 10. Cassieæ. 11. Detarieæ. lxiv. Rosaceæ 1. Chrysobalaneæ. 2. Amygdaleæ. 3. Spiræaceæ. 4. Neuradeæ. 5. Dryadeæ. 6. Roseæ. 7. Pomaceæ. lxv. Salicarieæ. lxvi. Tamariscineæ. lxvii. Melastomaceæ. lxviii. Myrtaceæ. lxix. Combretaceæ. lxx. Cucurbitaceæ. lxxi. Passifloreæ. lxxii. Loaseæ. lxxiii. Onagrariæ. lxxiv. Ficoideæ. lxxv. Paronychiæ. lxxvi. Portulaceæ. lxxvii. Cacteæ. lxxviii. Grossulaceæ. lxxix. Crassulaceæ. lxxx. Saxifrageæ. lxxxi. Cunoniaceæ. lxxxii. Umbellifereæ. 1. Hydrocotylineæ. 2. Bupleurineæ. 3. Pimpinelleæ. 4. Smyrnieæ. 5. Caucalineæ. 6. Scandicineæ. 7. Ammineæ. 8. Selineæ. lxxxiii. Araliaceæ. lxxxiv. Caprifoliaceæ. lxxxv. Lorantheæ. lxxxvi. Hamamelideæ. lxxxvii. Rubiaceæ. lxxxviii. Opercularieæ. lxxxix. Valerianeæ. xc. Dipsaceæ. xci. Calycereæ. xcii. Compositeæ. 1. Lactuceæ. 2. Carlineæ. 3. Centaurieæ. 4. Carduineæ. 5. Echinopseæ. 6. Arctotideæ. 7. Calenduleæ. 8. Tagetineæ. 9. Heliantheæ. 10. Ambrosieæ. 11. Anthemideæ. 12. Inuleæ. 13. Astereæ. 14. Sene cioneæ. 15. Nassauvieæ. 16. Mutisieæ. 17. Tussilagineæ. 18. Adenostyleæ. 19. Eupatorieæ. 20. Vernonieæ. xciii. Campanulaceæ. xciv. Lobeliaceæ. xcv. Gesnerieæ. xcvi. Vaccinieæ. xcvii.Ericeæ. xcviii. Monotropeæ.

§ § § *Petals combined in an hypogynous corolla.*

xcix. Myrsineæ. c. Sapoteæ. ci. Ebenaceæ. cii. Oleineæ. ciii. Jasmineæ. civ. Strychneæ. cv. Apocyneæ. cvi. Gentianeæ. cvii. Bignoniaceæ. cviii. Sesameæ. cix. Polemoniaceæ. cx. Convolvulaceæ. cxi. Boragineæ. cxii. Hydrophylleæ. cxiii. Cordiaceæ. cxiv. Solaneæ. cxv. Scrophularineæ. 1. Antirrhineæ. 2. Rhinanthaceæ. 3. Melampyraceæ. cxvi. Myoperineæ. cxvii. Pedalineæ. cxviii. Labiateæ. cxix. Verbenaceæ. cxx. Acanthaceæ. cxxi. Lentibulareiæ. cxxii. Primulaceæ. cxxiii. Globularineæ.

† † Incomplete.—*Calyx and corolla confounded.*

cxxiv. Plumbagineæ. cxxv. Plantagineæ. cxxvi. Nyctagineæ. cxxvii. Amarantaceæ. cxxviii. Chenopodeæ. cxxix. Begoniaceæ. cxxx. Polygoneæ. cxxxi. Laurineæ. cxxxii. Myristiceæ. cxxxiii. Proteaceæ. cxxxiv. Penæaceæ. cxxxv. Thymeleæ. cxxxvi. Santalaceæ. cxxxvii. Elæagneæ. cxxxviii. Aristolochiæ. cxxxix. Euphorbiaceæ. cxl. Calycantheæ. cxli. Monimieæ. cxlii. Urticeæ. cxliii. Piperaceæ. cxliv. Chlorantheæ. cxlv. Amentaceæ. 1. Ulmaceæ. 2. Salicineæ. cxlvi. Casuarineæ. cxlvii. Coniferæ.

* * Monocotyledoneous, or Endogenous.—(Vessels disposed in parcels, of which the youngest are in the centre. Cotyledons solitary, or alternate, or absent).

† Phænogamous. Fructification visible or regular.

cxlviii. Cycadeæ. cxlix. Hydrocharideæ. cl. Alismaceæ. cli. Orchideæ. 1. Neottieæ. 2. Arethuseæ. 3. Gastrodieæ. 4. Ophrydeæ. 5. Vandeæ. 6. Epidendreæ. 7. Malaxideæ. 8. Cypripedieæ. clii. Scitamineæ. cliii. Maranteæ. cliv. Bromeliæ. clv. Irideæ. clvi. Hypoxi-

deæ. clvii. Hæmodoraceæ. clviii. Amaryllideæ. clix. Hemerocallide. clx. Liliacæe. clxi. Melanthaceæ. clxii. Dioscoreæ. clxiii. Smilaceæ. clxiv. Asphodeleæ. clxv. Junceæ. clxvi. Butomeæ. clxvii. Restiaceæ. clxviii. Eriocauleæ. clxix. Commelineæ. clxx. Pontedereæ. clxxi. Palmeæ. clxxii. Pandaneæ. clxxiii. Aroideæ. clxxiv. Typhineæ. clxxv. Fluviales. clxxvi. Juncagineæ. clxxvii. Pistiaceæ. clxxviii. Cyperaceæ. 1. Cypereæ. 2. Scirpeæ. 3. Sclerineæ. 4. Caricineæ. clxxix. Gramineæ. 1. Paniceæ. 2. Stipaceæ. 3. Agrostideæ. 4. Bromeæ. 5. Chlorideæ. 6. Cereales. 7. Sacchárineæ. 8. Oryzeæ. Bambusaceæ.

† † Cryptogamous. Fructification unknown or irregular.

clxxx. Filices. 1. Polypodiaceæ. 2. Osmundaceæ. 3. Ophioglosseæ. clxxxi. Equisetaceæ. clxxxii. Lycopodineæ. clxxxiii. Marsileaceæ.

II. Cellular, or Acotyledonous. (System composed of cellular tissue without tubular vessels. Reproductive organs gemmaceous).

clxxxiv. Musci. clxxxv. Hepaticæ. clxxxvi. Algæ. 1. Diatomeæ. 2. Nostochinæ. 3. Confervoideæ. 4. Ulvaceæ. 5. Florideæ. 6. Fucoideæ. clxxxvii. Lichenes. 1. Idiothalami. 2. Cænothalami. 3. Homothalami. 4. Athalami. 5. Pseudo-lichenes. clxxxviii. Fungi. 1. Hymenomycetes. 2. Gasteromycetes. 3. Hyphomycetes. 4. Coniomycetes.

INDEX.

THE END.

ERRATA.

Vol. 1, page 59, for River St. Lawrence, read Niagara River.

Vol. 2, page 552, in the contents of Chap. XXII., the following w should be omitted :—" A View of the Animals peculiar to each contine

Vol. 3, page 33, 12th line from bottom, for Field Goose, read Wild Go The English Crow is spoken of in note to page 70, vol. 3, as more sc ble than the American Crow ; in a part of the edition the word *less* erroneously inserted for *more*.

Vol. 4, page 197. The description of the Sea Horse is inserted, wi had been previously noticed at page 114, under the title of Hippocam In the contents of Chapter VIII., the following words should have omitted: " The Art of Angling...Baits, &c. for Fishes...Praise of Angli